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FUNCTIONAL APPROACH TO WESTERN UNION

THE announcement on January 29 that the Brussels Treaty Powers had agreed to the formation of a Council of Europe has been described as an event which will go down in history as a milestone of our times. As such it must receive the earnest consideration of all thinking men.

In any such association of nations, the part which scientific workers have to play in the maintenance of peace has frequently been discussed. In November last the Committee on Science and its Social Relations made a report to the International Council of Scientific Unions on an inquiry into this matter, which it had carried out among representative scientific men. The replies showed general agreement that the greatest contribution which men of science can make is to stand firmly for full freedom of thought and expression and movement. This affirmation of the necessity of full intellectual freedom is linked up, moreover, with the recognition of the part which the international scientific unions have to play, as well as the United Nations Educational, Scientific and Cultural Organisation, in pursuit of international understanding and co-operation; and it should be noted that the chairman of the United States delegation to the Beirut Conference of the latter Organisation recorded the emphatic conviction of his delegation that the Organisation could only succeed on the basis of intellectual freedom. The direct contribution of science to the maintenance of peace, it seems, is to be essentially technical, though its indirect influence in other fields may not be negligible. There was little support for the idea that men of science as such could, or should, attempt to court any direct political influence.

Certain aspects of the formation and functioning of Western Union are ably discussed by Miss Barbara Ward in her recent book, "The West at Bay"*. She refers to the Middle East Supply Centre as an example of international planning during the Second World War, remarking that in some of its functions it had to deal with problems closely resembling those facing the association of the nations of Western Europe. Its success in dealing with various technical problems of supply and production then engendered the hope, expressed in these columns (**152**, 671; 1943; **153**, 691; 1944), that it might develop into a very valuable instrument of international co-operation in the Middle East. That hope was frustrated, however, by the withdrawal of the United States at the end of the War.

Yet another instance of successful co-operation in a technical field is cited by Miss Ward to illustrate the feasibility of a Western association. During 1945–47, when it was doing its main work, the United Nations Relief and Rehabilitation Administration included in its formal constitution all the Allies, and its achievements provide convincing evidence of the possibility of running even a system of allocations

* The West at Bay. By Barbara Ward. Pp. 234. (London: Allen and Unwin, 1948.) 12*s.* 6*d.* net.

and priorities on an international basis, provided the political goodwill of the participating nations is secured. Administrators whose ability and independence of mind are beyond question are also essential for success; but the possibility of forging an instrument for international planning cannot now be seriously questioned.

What is at issue is, of course, the way in which it should be used and the extent to which it should attempt to plan. On this Miss Ward points out that national and international experience alike suggest that planned control should be confined strictly to the essentials. Even this measure of world government will demand the sense of a great and overriding purpose and of high moral and spiritual qualities.

When, in conclusion, Miss Ward lays such stress upon those ideas of man's unique greatness but equal fallibility, of his fundamental rights and of the necessary limitations they impose on government, of the existence of an order of right and wrong, and good and evil, from which these rights are derived and which transcend man and society, she comes close indeed to the ideas disclosed and emphasized by the Committee on Science and its Social Relations. The conception of freedom which she elucidates is that which has illuminated all the debates of the past three years on the freedom of scientific work and thought in face of the military demands for secrecy. Her analysis, brief as it is, demonstrates convincingly that, however aloof men of science may keep themselves, as such, from political action, they cannot evade the responsibility for sharing in the challenging and formidable task of discovering the spiritual basis of a Western association.

Without such a basis, the prospects of a Western association of nations are slender. That much has been recognized from the start. Whatever the political means which are chosen to rally the forces of Western Europe, the terms in which Mr. Churchill at The Hague last May defined the conditions for which it is necessary to contend cannot be challenged and should commend themselves to all men of science who recognize what is at stake:

"The movement for European unity . . . must be a positive force, deriving its strength from our common sense of spiritual values. It is a dynamic expression of democratic faith based upon moral conceptions and inspired by a sense of mission. In the centre of our movement stands a charter of human rights, guarded by freedom and sustained by law. . . . After all, Europe has only to arise and stand in her own majesty, faithfulness and virtue, to confront all forms of tyranny, ancient or modern, Nazi or Communist, with forces which are unconquerable; and which, if asserted in good time, might never be challenged again."

To reach agreement on the technical questions of a Western association—such matters as defence, customs, transport, heavy industry and the like—will not be easy: to reach agreement on a political union will be a task of years. The prosaic and functional approach based on the Brussels Pact would seem to be the most practical line of development. It will call for all the help which public and private bodies in every country can give, and the recognition that the movement for Western Union requires such co-operation is an outstanding feature of the Labour Party's recent pamphlet "Feet on the Ground—a Study of Western Union". It is not often that a political party recognizes a mistake and makes amends so handsomely, and that gesture alone should encourage the co-operation from many spheres of life that will be required both to shape the functional instruments and to formulate more clearly in terms of modern life the Western tradition. The Lysenko controversy has brought to the world of science a fresh realization of the danger to the intellectual and spiritual independence which is both an essential element in a creative civilization and a vital part of that Western tradition. Freedom of thought has ever been the secret of all creative epochs and not of scientific advance alone. Scientific workers have their responsibility to rally in support of the maintenance of high standards of truth and taste, now threatened by mass hysteria, both national and class; but they can only fully discharge that responsibility in association with others.

Some of those other contributions were indicated by a meeting held in the Royal Albert Hall last April to demonstrate the support of the Christian community for the idea of Western Union; and on the Anglican side, the report of the Lambeth Conference contained some indications of an attempt to think out afresh the moral and spiritual foundations of Western Europe. The joint congress of the Classical Association and the Hellenic and Roman Societies at Oxford in August also showed that the classics have a place in Western Union and a distinct contribution to make in the formulation of a clearer understanding of the foundations of our Western civilization, with its Greek and Roman as well as Christian elements. That conference, indeed, gave a clue to a way in which the problem of specialization might be solved, and the contribution of the specialists integrated with the need for unity and a common inspiration; it gave an encouraging example of the way in which the professional man, individually and collectively, could help in the renaissance of Western Europe.

That a Charter of Human Rights has now been adopted by the United Nations has no doubt contributed to the achievement of Western Union. It gives concrete expression to one of the affirmations of the preamble to the Brussels Pact, and it should give fresh encouragement to individuals and professional associations to think out and formulate the further measures required both to secure the ultimate objective, and also the widespread understanding of the principles and ideals upon which the effective functioning of a Western association in any form depends. Upon the functioning and co-operation of such groups the preservation of individual freedom and of human rights in general will depend. The contribution of men of science will not be made solely in the technical field. Science itself is one of those cultural activities which has helped to shape the Western tradition. Scientific men in Britain might

render valuable service to the cause of a Western association of nations by developing their international contacts in Europe and America. In this way they can help their American colleagues, with whom they share so much of the tradition and ideals of Western Europe, to understand something of the difficulties which make the early federation of Western Europe impracticable, as against a gradual approach to an integration preserving the diversity on which European civilization partly depends.

The war-time experience which led to the creation of such instruments as the Middle East Supply Centre, the Combined Raw Materials Board, the Combined Production and Resources Board, the Anglo-American Caribbean Commission and the Supreme Headquarters, Allied Expeditionary Force (Shaef) has shown the lines on which a form of functional union might be achieved. To secure the forging of such instruments of European union in time of peace requires more than the threat imposed by a 'cold war'. It requires the sense of common purpose, ideals and traditions of which the Brussels Pact is the embryonic expression. In his book "From the League to U.N.", Prof. Gilbert Murray gave last year an account of the work of the Committee of Intellectual Co-operation which shows how important is the task of creating a strong international culture in the defence of peace and freedom. The task of intellectual co-operation has now passed to the United Nations Educational, Scientific and Cultural Organisation; and the main hope of Western Union and the preservation of the rich heritage of Western civilization may lie not so much in the success of functional co-operation—the crystallization of some sense of common economic and material interests—as in the extent to which that new Organisation, loyally supported and wisely used, is able to make plain, in Gilbert Murray's words, "some sense of values, of obligations, of things of beauty, which are somehow beyond question and which, at whatever cost of endurance, humanity must not betray".

CHEMOTHERAPY AS A SCIENCE

The Basis of Chemotherapy

By Dr. Thomas S. Work and Dr. Elizabeth Work. Pp. xix+436. (Edinburgh and London: Oliver and Boyd, Ltd., 1948.) 26*s*. net.

CHEMOTHERAPY was a term used by Ehrlich to denote the treatment with substances of known chemical composition of an infected host, in such a way as to destroy the invading organisms or to neutralize the toxic action of their products. A chemotherapeutic agent must therefore be a substance which has no action against the host, but specifically attacks the infecting organism and either kills it or renders it susceptible to the defence mechanisms of the host. Until recently, new chemotherapeutic agents have been discovered by accident and then subjected to chemical modification in an attempt to improve their effectiveness. The discovery of such drugs has been followed, often after an interval of many years, by elucidation of the nature of their action. There must, however, come a time when it will be possible to design drugs to inhibit processes peculiar to parasitic organisms and so produce chemotherapeutic agents on a rational basis.

It is doubtful whether there is yet sufficient knowledge of anabolic biochemistry or of the differences between host and parasite to provide such a basis, but Drs. T. S. and E. Work in "The Basis of Chemotherapy" have made a promising attempt to indicate the fundamental lines upon which such a development might be expected to take place. The book begins with a historical account of the development of chemotherapy, and the first half of the book then gives an excellent account of the present knowledge of cellular metabolism. In this section the authors summarize what is known of enzymes and their inhibition, essential metabolites and their relation to growth factors and prosthetic groups, metabolism of carbohydrate, fat and protein, together with outlines of the various oxidation and fermentation cycles involved. Here we have the known metabolism of the bacterial cell; but it should be pointed out, in a book on this subject, that much of this metabolism is common to both host and parasite, and it is very doubtful whether any effective chemotherapeutic agent can interfere in these systems. At present it seems probable that studies on the action of chemotherapeutic drugs will reveal the nature of the underlying essential metabolism rather than *vice versa*.

The discovery of the antagonism between *p*-aminobenzoic acid and sulphanilamide provided the first real indication of a possible mode of chemotherapeutic action, and this subject is examined in detail, together with its extension into the general field of drug antagonism. The authors deal with antagonism of arsenical and heavy-metal drugs and present a critical survey of the possibilities and limitations of the use of metabolite analogues. It is hoped that future editions will include some discussion of the recent reports of antagonism of penicillin and acridines by nucleoprotein and of streptomycin by lipositol, although at the moment such findings merely emphasize the gaps in our knowledge of the underlying metabolism. A point of minor criticism is that the authors several times refer to penicillin as bacteriostatic, whereas much of the later work on this antibiotic indicates that its action is lethal and irreversible.

One of the most interesting aspects of drug action on bacteria concerns acquirement of resistance, and the chapter on this subject forms the most useful and informative in the book. Resistance to penicillin and the sulphonamides is the result of selective growth of resistant mutants; these may arise by production of metabolic pathways alternative to those blocked by the drug, by increased production of the competitive analogue, by production of an enzyme destroying the drug, etc. The authors give an excellent exposition of these aspects and also deal with the possibilities of drug resistance arising other than by mutation as suggested by the work of Hinshelwood and co-workers. Finally, there is an authoritative chapter on the relation between chemical structure and activity. Subjects dealt with here include the variation of activity with structure of surface-active substances, basic dyes and sulphonamides; much otherwise scattered but relevant material on ionization and resonance effects are usefully collected here.

So far as we know at present, chemotherapeutic action can affect the cell in three ways: by alteration of its surface properties, by direct inhibition of an essential enzyme, or by competitive inhibition of an essential metabolism. The authors' avowed object is to "focus attention on the modes of action of drugs rather than upon the synthesis of ever more variants on their chemical structure", and they may be congratulated upon achieving this object. There are no data in the book on either clinical applications or the experimental side of chemotherapy, and both the medical man and the bacteriologist would probably prefer that the title should be modified to "The Biochemical Basis of Chemotherapy". E. F. G.

THEORETICAL ACOUSTICS

Vibration and Sound

By Philip M. Morse. (International Series in Pure and Applied Science.) Second edition. Pp. xix+468. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 33*s*.

DR. P. M. MORSE, who has made a number of contributions to theoretical atomic physics, shows in the present book that the new mathematical techniques which have been developed for the working out of quantum mechanics can be used to analyse such problems as the behaviour of sound in rooms. A course given by him at the Massachusetts Institute of Technology led to the writing of the book. According to the preface to the first edition, which appeared in 1936, it is intended primarily as a text-book for students of physics and of communications engineering.

The first aim is to give the student a general introduction to the theory of vibration and sound, and the second to give him a series of examples of the method of theoretical physics so that he may gain an insight into the way in which a theoretical physicist attacks a problem. Presumably the student of physics whom the author has in mind is one who has approached physics via mathematics, rather than one whose bias is towards experiment. Physics students at universities in Great Britain are not usually expected to devote much time to acoustics, and the intensive mathematical treatment would scarcely be the most effective way of giving them an introduction to the physical principles of recent work in acoustics. Students of mathematical physics will find, however, that they are provided with a systematic exposition of a powerful method of handling many acoustical problems. Research workers in acoustics will be particularly interested in the last chapters, where the theoretical work of Morse and collaborators on absorption and the acoustics of rooms is summarized.

Emphasis is laid on the usefulness of determining the characteristic functions for the normal modes of vibration, the behaviour of a flexible string being examined at some length as the simplest case of a system with an infinite number of allowed frequencies. Vibrations of bars, membranes and plates are then investigated in a similar manner. Analysis of sound waves in air commences with propagation in tubes, in connexion with which the concept of acoustic impedance is first used, followed by a chapter on radiation and scattering, which includes sections on absorption at a surface and transmission through ducts.

The present edition is more than a hundred pages longer than the first one. Some parts have been rewritten; but the main change is the insertion of new material, especially sections dealing with transient phenomena by the technique of the operational calculus. The physical principles underlying the mathematics are well brought out, but there is little attempt to compare the theoretical conclusions with experimental results. Very few references are given, and the reader has to find out for himself in what respects the present treatment differs from that of the classical treatises. For the particular fields which it covers, however, Dr. Morse's book will continue to be of great value.

WORLD FOOD PRODUCTION

Feeding the Human Family

Science Plans for the World Larder. By F. Le Gros Clark. (Sigma Introduction to Science, 11.) Pp. ix+125+8 plates. (London: Sigma Books, Ltd., 1947.) 7*s*. 6*d*. net.

IT would be a thousand pities if the misleadingly modest title of this little book, and its inclusion in a series where it is a manifest misfit, were to prevent its having the widest possible circulation. It might perhaps more aptly have been called "Cold Water on Hot Springs". It is one of those rare books that combines science with humanity, that marries a passion for justice and human rights with a hard logic that faces facts. It is as much, if not more, a book for the expert as for the non-scientific inquirer.

Mr. Le Gros Clark's burning conviction that every man, woman and child in the world, without malefit of race, creed or colour, should have access to a diet that can give optimum nutrition is known to all specialists in relevant branches of science in Great Britain, and to many overseas; this conviction is even more intense than that of many of those who attended the Hot Springs Conference and founded the Food and Agriculture Organisation of the United Nations. But his appreciation of the difficulties confronting any attempt to translate into practice the ideals of the former, or even to achieve the much more limited objectives of the latter, is also greater than that of many other enthusiasts for the full larder as a condition precedent for the full life.

The argument of this short essay is already so concise that it would be folly to attempt further condensation. It covers the ground from consideration of individual, regional and national dietary patterns to world markets; it is concerned as much with the raising of crops and stock as with the transport of processed food from factory to consumer; it recognizes in agriculture an essential industry even more than a way of life. The author, in tackling the contradiction between food surpluses and simultaneous hunger, or indeed famine, has surely made it again abundantly clear that no sincere nutritionist can 'keep out of politics' and yet face the economic issues involved.

Not the least among this book's many virtues is the simple and, generally, attractive and accurate way in which it is written, and not the least among its author's claims to distinction is that the extreme seriousness of his subject never causes him to lose his sense of proportion—or indeed of humour. But perhaps Mr. Le Gros Clark's greatest merit of all is that not only does he see the wood as well as the trees, but that he has also with scrupulous fairness and great technical knowledge examined many of

the trees against which some of the world's experts in food and agriculture have been barking their individual and collective shins. He has, moreover, on many occasions shown those experts the way—and generally the only way—in which those trees can be cut down, to make a path through the jungle of anarchic production and inequitable distribution to that world of plenty now so often promised by the United Nations. A. L. BACHARACH

ANALYSIS OF OSCILLATIONS

Frequency Analysis, Modulation and Noise

By Dr. Stanford Goldman. (Radio Communication Series.) Pp. xiv+434. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 36*s*.

THE manner in which this book has been written enables any one of the subjects mentioned in the title to be studied alone; but there are sufficient cross-references to indicate the relationships between them. Much of the material contained in the first section, dealing with Fourier analysis, can be found elsewhere; but it is presented here in a form particularly useful to radio engineers. The author maintains that mathematics should not be regarded merely as a convenient tool or a shorthand language to facilitate the solution of engineering problems, but as a subject exhibiting natural phenomena of its own. In support of this argument he mentions the many scientific discoveries which were made as a result of a mathematical investigation rather than by planned experiment. Certainly the mathematical treatments are presented in such a way that their practical importance is constantly in mind.

The comparatively short section which deals with the basic theory of modulation again contains material which can be found scattered among various text-books; but more than usual attention has been paid to the fundamental similarities and differences between the various types of modulation.

The chapters on noise occupy half the book and are based largely on papers which have been published during the last few years. The importance of a statistical approach to the subject has been given an emphasis which will be particularly valuable to those readers with no previous knowledge of noise phenomena. Random noise, of the type caused by shot-effect in valves and thermal agitation in impedances, has been treated at length; but atmospheric and man-made noise are worthy of more than the brief mention given to them. Space might have been found also for the important subject of crystal noise, and a treatment of the interaction of non-random noise with a signal would have been useful to those concerned with jamming techniques.

The author's teaching experience has enabled him to produce a book suitable for students, in that many queries on interesting side-issues have been anticipated. A useful selection of exercises has been introduced at appropriate points in the text. At the same time, the clear lay-out of the text and diagrams, the full list of contents, and the index make the book equally useful for reference purposes.

In cutting down the mathematics to the essentials, the author has not forgotten those who wish to study the subjects more deeply, and an adequate supply of references to original papers is provided. As is often the case in American publications, however, a number of valuable papers published in British journals find no mention. F. HORNER

SYMPOSIUM ON HORMONES

Recent Progress in Hormone Research

The Proceedings of the Laurentian Hormone Conference. Vol. 2. Edited by Gregory Pincus. Pp. v+427. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1948.) 8 dollars.

VOLUME 2 of the "Recent Progress in Hormone Research" is in effect the *Proceedings of the Laurentian Hormone Conference* for 1946. This meeting has become a very successful affair and is widely attended by workers connected with this field. The volume at present under consideration is largely concerned with the metabolism of hormones. It is divided into five parts, and each paper is followed by a summary of the discussion, with the names of those taking part and their comments given in considerable detail. As a rule, discussion reported long afterwards makes poor scientific reading; but it must be stated that in this volume the editors have obviously gone to great trouble to cut out the monosyllabic inanities that so frequently disfigure this type of discussion.

Section 1 is entitled "Physical Methods in Hormone Research" and consists of two papers. The first, by R. N. Jones on the characterization of steroid hormones by ultra-violet and infra-red spectroscopy, is an extremely valuable account of this very modern development in North America. It serves as an excellent introduction to the important and complicated work being performed by Dobriner and his colleagues. It is very difficult for the British reader to appreciate the importance of infra-red spectroscopy, as hitherto we have not had the apparatus. These beautiful self-recording infra-red spectroscopes are commonplace instruments in America, and they greatly speed up the investigation of steroid excretion products. The discussion on this paper is particularly interesting and is opened by Dobriner. The second paper, by Friedgood and Garst, is on the identification and determination of œstrogens by ultra-violet spectroscopy. Here again the European reader can see the enormous importance of these automatic and self-recording instruments. This paper indicates that the excretion of œstrogens, which has hitherto been very unsuccessfully investigated, will now yield results to this type of method, and a new field has therefore been opened.

It is not possible to consider the remaining four sections in the same detail, but they follow the same method of presentation. They are concerned with the control of the pituitary, the metabolism of certain steroid hormones, the hormonal regulation of metabolism, and a final section on clinical endocrinology. This last is particularly interesting and contains three papers. The first, by E. P. McCullagh, is on sex-hormone deficiencies; the discussion following this paper is particularly interesting and can be read with great profit. The second paper is on adrenal cortical tumours and Cushing's syndrome, and is by E. J. Kepler, R. G. Sprague, H. L. Mason and M. H. Power. This again is interesting in that it deals with the excretion products, and it is certainly a very valuable contribution to this subject.

In conclusion, the volume is very definitely an essential one for workers interested in endocrinology. Each section has an adequate series of modern references, and the reader may be certain that if he is familiar with this work he will at least be as up to date as the book itself. E. C. DODDS

Organic Analytical Reagents

By Prof. Frank J. Welcher. Vol. 3. Pp. xi+593. Vol. 4. Pp. xiii+624. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1947.) 44*s*. net each.

IT would appear that these two volumes complete the author's survey of organic substances used in analysis. Volume 3 deals with heterocyclic nitrogen compounds, oximes and acidic imino compounds, and volume 4 with a number of groups of compounds, including alkaloids, other natural substances and various classes of dyes. Among the more important sections in volume 3 are extensive reviews of the uses of dimethylglyoxime (60 pages), cupferron (41 pages), and dithizone (83 pages), with detailed discussions of the conditions for their use and the factors determining the stability of the complexes formed with metals. The bibliographies in these three sections alone contain some 670 references to the literature.

The usefulness of these volumes as a work of reference would be much increased by the addition of combined indexes covering all four volumes. The analyst who uses them to find what reagents are suitable for the detection or determination of a given metal will otherwise have to search four indexes in every case. The general arrangement of the organic substances is also in some respects arbitrary; for example, the reagent 8-hydroxyquinoline is found in volume 1 under phenols and not in volume 3 under heterocyclic nitrogen compounds, so that in the absence of a combined index the search for a given organic reagent will also often involve the perusal of more than one list. However, this is a minor point, and there can be no doubt that these volumes are the key to an enormous amount of detailed information and will be of great value to the practical worker. G. M. B.

The Birds of Tropical West Africa

With Special Reference to those of the Gambia, Sierra Leone, the Gold Coast and Nigeria. By Dr. David Armitage Bannerman. Vol. 6. Pp. xxxix+364+14 plates. (London: Crown Agents for the Colonies, 1948.) 35*s*.

AFTER a gap of eight years due to the War and its after-effects, publication of this important work is resumed with the appearance of the sixth volume; and one is glad to note that the remaining two volumes are ready for press. The present volume covers seven families of the Passeriformes; the seventh will deal with the weaver-birds; and the eighth will contain additional information that has meanwhile come to hand on the subjects of the first five volumes. This last will certainly be an essential part of the work, as the first volume appeared so long ago as 1930, and something of the kind would have been necessary even if the period of issue had not been prolonged by the War.

The whole work gives a systematic account of all the species of birds known to occur in the Gambia, Sierra Leone, the Gold Coast and Nigeria. For each species there is given a description, with notes on field identification, and an account of what is known of its range and local distribution and of its habits. Such comprehensive documentation for the avifauna of tropical territories is quite unusual, and the Governments of the four Colonies have done well to sponsor the undertaking. The work will provide an invaluable base-line and guide for all further ornithological studies in the area, about the birds of which there is naturally still a great deal to be discovered. In congratulating the author on the approaching completion of his task, one is also glad to note that the standard of production has been well maintained in this post-war volume.

The Petrography and Petrology of South African Clays

By V. L. Bosazza. Pp. xv+313+18 plates. (Johannesburg: The Author, 39 Barkly Road, Parktown; London: Percy Lund, Humphries and Co., Ltd., n.d.) 42*s*.

THIS volume serves a useful purpose by bringing together a variety of chemical, physical and petrological data which have been obtained by the author and others over a period of years. It deserves to be referred to frequently, and one must regret, therefore, that the arrangement of the text makes reference difficult. The numerous analyses are quoted mainly as illustrations in the development of a general thesis on the nature of clay, and consequently data on the same or neighbouring clay deposits are often widely scattered. The index is not sufficiently complete to repair this fault.

The term 'clay' is interpreted in a wide sense, and analytical data are given on soils, siliceous deposits, iron–alumina hydrates and tillite, as well as on such materials as fireclays and kaolins. There is an almost complete absence of data obtained by modern physical techniques (X-ray diffraction, electron microscopy, differential thermal analysis), and the author's reference to the X-ray method (p. 167) suggests that he does not appreciate its present possibilities.

The book is very legibly reproduced from typescript by the 'Replika' process, but readability is impaired by numerous errors in the original typescript. The voluminous list of general references indicates a thorough acquaintance with the literature of clay mineralogy, and most readers should find in it something new to them. DOUGLAS M. C. MACEWAN

Mereside Chronicle

With a Short Interlude of Lochs and Lochans. By C. F. Tunnicliffe. Pp. 200. (London: Country Life, Ltd.; New York: Charles Scribner's Sons, 1948.) 42*s*. net.

MR. Tunnicliffe's "Mereside Chronicle" is an account of peaceful waters in lovely country settings, where birds of many kinds disport themselves undisturbed.

As a bird artist Mr. Tunnicliffe is not only well known to the ornithological world but also to a wider public. He is skilled in depicting feathered life, having that delicacy of touch which is necessary for the successful portrayal of birds.

The illustrations to this handsome volume are many: that used on the jacket, of Canada geese and goslings, being particularly satisfying, for one reason because the black, white and grey subject is especially suitable for reproduction in monochrome.

It is a pity that some of the lovely subjects could not be reproduced in full colour, for the artist we know is as much master of the brush as he is of pencil and pen.

By the way, Mr. Tunnicliffe does not confine himself to English subjects, and his sketches of divers in the Highlands are full of life, as also are other pictures of Scottish birds. F. P.

CHROMATOGRAPHY AND ION-EXCHANGE

RECENT years have seen the development of many new techniques of importance to the chemist; of these, chromatography and ion-exchange have received special attention of late. A well-attended discussion of these methods, arranged by the Chemical Society, was held on November 25, in the Chemistry Department of the Imperial College of Science and Technology, an afternoon session being devoted to chromatography (including partition chromatography), while ion-exchange was dealt with in the evening.

In opening the afternoon meeting, the president, Sir Ian Heilbron, remarked that this was a new departure for the Society or, more correctly, a return to earlier practice. He paid tribute to Dr. R. P. Linstead, who had been largely responsible for arranging the discussion, and called on him to introduce the speakers and the subject.

Dr. Linstead indicated that although the title of the discussion was wide, it would be limited to chromatography and ion-exchange. These resemble each other in being usually operated in columns in which there occurs the distribution of substance between a solid and a liquid phase in a continuous and moving system. There are similarities also to fractional distillation and solvent extraction. Dr. Linstead said that, in addition to the applications of these techniques, speakers would also deal with the principles underlying them, for many of the failures of earlier workers had been due to a lack of knowledge of fundamentals; in introducing the speakers he gave a particularly warm welcome to Dr. Stig Claesson, of Uppsala, Sweden.

The afternoon discussion was opened by Dr. E. Glueckauf with a paper on "Factors Influencing the Efficiency of Chromatographic Separations". He pointed out that there are three fundamental factors to consider, namely, non-equilibrium, diffusion, and theoretical plate effect, and equations were derived summing the influence of these on the form of the boundary between two solutes. The relation of these factors to such experimental variables as grain size, flow-rate, column diameter, temperature and uniformity of packing was considered, and it was shown that for ion-exchange the non-equilibrium factor is the most important one. From this it can be deduced that there are advantages in having a small grain diameter, a low effluent velocity and a high temperature. In organic chromatography, where equilibrium is rapidly achieved, the predominant factor is the plate effect; with a low separation factor it is desirable to have a small grain-diameter and long narrow columns. Examples were given illustrating these points.

Dr. Claesson, who was warmly received, then spoke on "The Adsorption Analysis of High Molecular Substances", and described some of his recent work on the chromatography of high polymers. For this work some changes have been made in the experimental procedure, for it has been found that the insertion of several smaller column-filters after the first one increases the sharpness of the front boundaries; changes in the concentration of the solution leaving the chromatographic column are followed by changes in the refractive index. The advantages of activated carbon as an adsorbent were referred to, and results obtained with such substances as polymethyl methacrylate, polyvinyl acetate, nitrocellulose, glue, etc., were described. Contrary to the behaviour of substances with low molecular weight, the adsorption of these macromolecular materials decreases with increasing molecular weight, the change of behaviour occurring in the region between 5,000 and 10,000. Frontal analysis has been mainly used; but displacement development and elution analysis have also been employed. The best results are obtained with very dilute solutions, and, by extrapolating to zero concentration, a good approximation of the weight distribution function is obtained. The results also agree with those arrived at by fractional precipitation followed by ultracentrifuging. In the field of high polymers, adsorption analysis is useful in determining the degree of polymerization, in determining the purity of a material, or in obtaining information as to branching or end-groups in a polymer chain.

Dr. A. J. P. Martin, one of the pioneers of partition chromatography, then spoke on "Partition Chromatography in Relation to Other Methods of Purification". The enrichment factor of two substances relative to one another in different phases depends on the difference in the energies required to move them from one phase to the other. The energy can comprise Van der Waals forces, hydrogen bonds, or ionic forces. The influence on the partition coefficient of hydrogen bonding with the solvent was discussed, and it was pointed out that whereas the partition coefficients of serine and alanine are the same, that of tyrosine is much more favourable in collidine than the partition of phenylalanine. With ionic substances on buffered columns it is possible to follow changes in the eluate by determinations of conductivity. An automatic apparatus for collecting fractions and determining conductivity was described, and some of the chromatograms obtained with crude penicillins and other materials were shown.

"The Separation of Inorganic Substances on Cellulose" was then dealt with by Dr. R. P. Linstead. Hitherto, partition chromatography has been applied only to organic substances, but work at the Chemical Research Laboratory at Teddington has revealed that many inorganic separations can be achieved by this technique, whether carried out on paper strips or on columns of cellulose. The method consists in bringing together into contact the inorganic substances to be separated, cellulose and a suitable organic solvent which usually contains acid or some other reagent. The system also contains water, which is present either as a normal constituent of the cellulose or through deliberate addition to the solvent. Activation of the cellulose by nitric acid is advantageous in many cases. It was shown that several factors may play a part in these separations, such as sorption on the cellulose, partition between the solvent and water, and complex formation. The technique can be employed for analytical and preparative purposes, and examples of both were given. Actual separations were demonstrated during the lecture.

The final speaker at the afternoon session was Dr. C. E. Dent, who described the separation of amino-acids and polypeptides by partition chromatography. Three methods were dealt with, the silica-gel column, the potato-starch column, and the filter-paper tech-

nique in one- and two-dimensional forms. The merits and disadvantages of these methods were discussed. For the study of biological fluids the paper chromatograph has provided the most useful procedure for the separation of complicated mixtures of peptides and amino-acids. Only microgram quantities of material are required, while the resolving power is high. The various spots on a chromatogram can be identified by comparing their position with those of known substances on a standard chromatographic map. Such a map was shown containing more than sixty amino-acids and related substances.

A general discussion followed in which a considerable number of questions were put to the various speakers.

The evening session, under the chairmanship of Dr. R. P. Linstead, was opened with an introductory paper by Prof. C. W. Davies. Prof. Davies pointed out that, in separations of acids on a basic exchanger, the optimum *p*H may be lower than the calculated value, owing to the existence of a zeta potential. He also emphasized that, in organic separations, the simple ionic mechanism may be modified by specific adsorption effects. The non-ionic adsorption of acids on acidic resins may be as high as 1 m.equiv./gm., a value which is of the same order as the total ionic capacity.

The second paper, "The Properties of Ion Exchange Polymers in Relation to their Structure", by N. E. Topp and K. W. Pepper, was read by Dr. Pepper. The influence of macromolecular structure, for example, degree of cross-linking and nature of chemical bonds, on such properties as swelling, solubility and chemical stability was outlined. Curves relating the capacity of an exchanger of known preparation to the equilibrium *p*H were presented. Monofunctional cation exchangers, containing only one type of acidic group, namely, sulphonate alone, carboxyl alone and phenolic hydroxyl alone, were first described. With sulphonated cross-linked polystyrene, the capacity is independent of *p*H over a wide range, and agrees closely with the value calculated from the sulphur content. The capacity of the carboxylic and phenolic exchangers varies with *p*H, and indeed it is not possible to obtain a limiting capacity of the latter material. The capacity-*p*H curves of polyfunctional exchangers, containing, for example, sulphonate and hydroxyl, carboxyl and hydroxyl, consist of segments characteristic of the ionizable groups present. The results emphasize the advantages of monofunctional exchangers in separation work, in that only one set of fundamental data, for example, distribution coefficients, exchange-rates and swelling, is required.

Dr. J. F. Duncan read the paper "Chromatographic Studies of the Sodium–Hydrogen Ion Exchange Equilibrium", by J. F. Duncan and B. A. J. Lister. Elution curves have been obtained for the sodium–hydrogen ion exchange system, and the mass action constant K_a determined by three methods: (*a*) by application of the Glueckauf equation; (*b*) by measurements of the elution volume necessary for solutions of different hydrogen–sodium ion ratios; (*c*) by the batch equilibrium method. The concentrations of sodium ions in each case are measured by use of the 14·8-hour half-life sodium-24 activity. The method is applied to two exchangers, 'Dowex 50', a simple sulphonic acid exchanger, and 'Amberlite I.R. 100H', a mixed sulphonic-phenolic exchanger. The elution curves obtained are independent of the flow-rate in a range of $1{\cdot}75 \times 10^{-3}$ to 10^{-2} cm./sec., showing the system to be in equilibrium. In the case of 'Amberlite I.R. 100H', a further small uptake of sodium ions occurs after the initial break-through due to exchange of the phenolic hydrogen ions. The capacity of 'Amberlite I.R. 100H' at *p*H 7 is 1·63 m.equiv./gm. and at *p*H 11 is 2·52 m.equiv./gm., of which only 1·50 m.equiv./gm. are due to exchange of the hydrogen atoms of sulphonate groups. The capacity for 'Dowex 50' at all *p*H's is 4·3 m.equiv./gm., a somewhat lower value than that given by American workers. With both resins, K_a remains constant for molar fractions of sodium ions in solution which are between 0·2 and 0·8, but rises significantly for molar fractions below 0·1. The values of K_a over the constant range are $1{\cdot}24 \pm 0{\cdot}015$ for 'Amberlite I.R. 100H' and $1{\cdot}52 \pm 0{\cdot}015$ for 'Dowex 50'.

The paper, "Equilibrium Studies with a Cation-Exchange Resin", by J. A. Kitchener and T. R. E. Kressman, was read by Mr. Kressman. He presented a number of interesting generalizations regarding the relative affinities of various cations for a phenol-sulphonate resin. Broadly, the affinities increase with increasing charge, but there is a considerable overlap. Contrary to common assumption, this is not in accordance with a simple Coulomb model. The distance a_0 of closest approach to cation and anion is the determining size-factor for the alkali metals. It may be for divalent ions also, but the effect is largely masked by incomplete dissociation of the salts. In contrast to the simple metal ions, the affinity of large organic cations increases with increasing size up to a limit depending presumably on the pore size of the resin. Incomplete dissociation is an important factor with the thallous and many polyvalent cations, and also with weak acids. The chief effect of concentration is that predicted by the law of mass action for such solid–liquid systems, namely, negligible influence for solutions containing cations of equal valency, and increased adsorption of ions of higher valency with increased dilution. Complex-ion formation may greatly reduce ion exchange, which is also influenced by the nature of the solvent.

This interesting contribution was followed with a paper by Dr. S. M. Partridge, who spoke on "Separation of Amino-acids by Displacement Chromatography on Ion-Exchange Resins". Dr. Partridge described the fractionation of a hydrochloric acid hydrolysis product of commercial egg-albumen on a column of 'Zeo-Karb 215'. Since the amino-acids, tyrosine and phenylalanine, behave irregularly on the column, these are first removed by adsorption on prepared charcoal. The mixture of amino-acid hydrochlorides (containing a small excess of hydrochloric acid) is applied to the column, and the mixed band so obtained is developed by displacement with 0·15*N* ammonia; the effluent solution is collected by means of an automatic arrangement in sixty-four fractions, each of 90 ml. The flowing chromatogram is analysed by paper chromatography, and the results show the presence of seven discrete bands: 1, aspartic acid; 2, glutamic acid, serine and threonine; 3, glycine and alanine; 4, valine and proline; 5, leucine, isoleucine, methionine and cystine; 6, histidine and an unidentified substance; 7, lysine. Arginine has a greater affinity for the resin than ammonia, and thus it remains on the column. Modifications in the experimental conditions, which may be used to effect a further separation of the components of the individual bands, were also described.

The last paper, "Ion-exchange Properties of Alginates", by I. L. Mongar and A. Wasserman, was read by Dr. Wasserman. Using a flowing system with highly swollen alginate in fibre form, the ratio k_1/k_2 and the velocity coefficient k_2 have been estimated for the following reaction:

$$\text{Ca } Alg + \text{NaCl} \underset{k_2}{\overset{k_1}{\rightleftharpoons}} \text{CaNa } Alg + \text{CaCl}_2.$$

The calculation of k_2 is based on a knowledge of the diffusion coefficient of calcium chloride in calcium alginate. The value of k_2 obtained is independent of the surface/volume ratio of the gel, and is only moderately influenced by the sodium chloride concentration, *p*H and temperature.

WIND AND OCEAN CURRENTS

A GEOPHYSICAL Discussion on "Wind and Ocean Currents" was held in the rooms of the Royal Astronomical Society on November 26. The chairman, Dr. A. T. Doodson, emphasized the great complexity of the subject, and gave a brief summary of its various aspects.

The list of problems is headed by the tangential stress between air and water, and this is related to the problems of turbulence in general, and of hydraulic flow. In pipes and channels, the roughness factor remains constant at any one place; but the surface of the sea is hydrodynamically smooth in the early stages of wind action and hydrodynamically rough in the later stages as the waves are developed. It may be expected that there will be considerable variation in the mechanism by which one fluid acts on the other in the varying conditions. The critical velocity of wind for the setting up of waves, as given by Jeffreys (110 cm./sec.), appears to be well established; a second critical value of about 700 cm. per sec., about which there is a rapid change in the stress coefficient, appears to correspond to the change from laminar to turbulent flow. In the earlier stages of development of waves, the surface tension of the water plays a part, but there is still some obscurity with regard to the mode of formation of waves in the initial stages.

After a wave is well established, its growth brings other considerations into prominence. Some investigations by Jeffreys, which showed how the pressure variations on the various parts of the wave influenced its growth, have been supplemented by Sverdrup and Munk, who have added a term depending upon the tractive forces which exist when the waves are well developed.

It is in connexion with well-developed waves that practical interest has lain in recent years. Naval operations off beaches, for example, have stimulated investigations into waves of large amplitudes, in the first place, and thence to associated waves. The laws of decay of wave systems are still somewhat obscure as there are two causes of decay: the air resistance as the wave progresses in calm air, and eddy viscosity. It has been recently stated that the former is the sole factor; but this may be doubted for large waves.

The next stage of the problem is that of the transport of volume. In this the part played by the waves tends to go out of sight, but should not be forgotten. Also the influence of the earth's rotation becomes prominent, though it receives little consideration with regard to the genesis and growth of waves. Ekman's theory of wind-driven currents is well established, but is being developed to allow for the influence of boundaries, at the bottom or near the coasts.

Finally, there is the problem of the gradients of surface set up in restricted seas. In this, further considerations arise, bringing in the variation of depth, the free period of the sea, and the characteristics of the atmospheric disturbances, as well as the decay. The part played by wave action in the absorption of energy in these storm surges may be of some importance. This problem differs from that of waves in deep water in that the bottom friction also is of importance. In this end-problem very striking progress has been made in recent years.

To sum up, the problems range from molecular effects to large-scale effects, and it is their interrelation which needs to be borne in mind when considering the details.

Dr. G. E. R. Deacon pointed out that the energy required to maintain the circulation of water in the oceans can be supplied by the effects of heating, cooling, evaporation and precipitation, and by the stress of the prevailing winds on the surface. Some of the deep-water movements which have velocities of the order of 1 cm. a second may prove to be convection currents, but various lines of investigation show that the surface currents in the oceans, which flow much faster, must derive most of their energy from the wind.

Ekman's theory of wind currents requires that the drift at the surface, in deep water far from land, should be directed 45° to the right of the wind in the northern hemisphere. The average inclination of the surface drift to the wind in different parts of the ocean has been studied by Krummel, Jeffreys, Durst and others, and it proves to be approximately 45°. Jeffreys, interested in the degree of turbulence in wind currents, mentions that this close agreement confirms one of Ekman's basic assumptions, that the eddy viscosity does not change with depth in the water layer affected by the current; but its magnitude, determined by comparing the observed velocities of wind and current, is of the order of 1,000 times as large as the value of eddy viscosity required by Jeffreys's theory of wave generation. This discrepancy is confirmed by recent work, and waves which are known to travel thousands of miles would be damped out in a few hours by viscosities as large as that required to generate wind currents. No explanation has been found for the discrepancy.

Another effect of the wind is the formation of convection cells in the water. Langmuir noticed that weed in the Sargasso Sea became arranged in parallel lines down wind, and showed, by careful measurements in a lake, that such lines mark zones in which the surface water is converging and sinking; midway between them he found that the sub-surface water was rising and diverging. A further study was made in the Gulf of Mexico in winds of force 2–4 by Woodcock. He prepared a hundred special numbered drift bottles, each with the minimum buoyancy to keep it awash at the surface, and rowing a small boat across the wind he threw out one bottle every 2 metres. Within 3–5 minutes, the bottles were always re-formed into new lines parallel to the wind. From Langmuir's work and his own it was known that the water in the convergences moves down wind more rapidly than the water between them, and it was assumed that the leading bottle in each line was

dropped nearest a convergence. If the convection cells were symmetrical, the leading bottle in each line should be followed by equal numbers from the left and the right; in all but three of his eighteen experiments, however, there were more from the left, and the average was 60 per cent. He concludes that the right-hand convection cell is most strongly developed.

Attempts have been made to use the effect of the earth's rotation to explain the symmetrical development of the convection cells, but without success. Munk has suggested that the convection cells are combined with a drift of the Ekman type.

Mr. F. Ursell then outlined an investigation of waves as they are affected by the rotation of the earth. It was shown by Stokes that regular trains of water waves are accompanied by a mass transport in the direction of propagation, provided that the effects of non-conservative forces such as the viscous forces and the Coriolis force are negligible so that the waves are free from vorticity. It has been suggested that this transport might set up large-scale ocean currents. However, in geophysical applications, the Coriolis force may not be negligible and vorticity may be generated. This question requires mathematical study. An idealized problem has been considered by Mr. Ursell in which the geopotential gradient (including the centrifugal force) is constant in magnitude and direction; so the wave motion may be thought of as taking place on a plane earth, on which there is a Coriolis field. In the first place, considering regular wave trains which can travel unchanged in such a field, it is necessary to take the non-linear equations of motion, as the mass transport is considerable only for waves of substantial height. But for non-linear equations the principle of superposition does not apply, so that we cannot hope for a complete solution of the equations. (An illustration was given of the difference between linear and non-linear behaviour.) Nevertheless, a good deal can be said about the mass transport. Mr. Ursell began by showing that the plane touching all the crests is normal to the direction of gravity. Then, by an extension of Bernoulli's theorem, it was shown that the mass transport, if any, must be in the direction of propagation. Finally, Bjerknes's theorem on the circulation along a circuit moving with the fluid was used to show that the mass transport at any depth is zero, so that the fluid particles move in closed orbits. The stationary state of waves on a rotating earth must therefore approximate closely to the type studied by Gerstner (1802) rather than to Stokes waves. The foregoing arguments do not apply on the equator.

Bjerknes's theorem may also be applied to the non-stationary state. Consider an area of still water which is being invaded by waves. The motion is initially irrotational, so that the waves formed in this area are initially of Stokes type. As they build up, a mass transport is set up. Bjerknes's theorem then shows that this current changes its direction continuously, the direction turning through four right angles in 12 $\operatorname{cosec}\varphi$ hours, where φ is the latitude. Ocean waves should therefore be accompanied by rotating inertia currents. Such currents have hitherto been explained as set up by a wind drag on the surface which ceases when a current has been established. This requires a large value of the eddy viscosity, which would lead to very rapid damping of the resulting motion. It may be that the wave mechanism described here will serve to explain some known inertia currents satisfactorily, but further measurements of waves are needed before a detailed comparison can be made.

Lastly, Mr. R. H. Corkan gave an account of the derivation of certain constants of the sea, of interest to oceanographers, a by-product of his work on storm surges. These surges are waves of much longer periods than surface waves, and the associated transport of water is of great importance. It might be thought that a single well-developed surge would give information as to the period of the oscillation, and that its rate of decay would give an approximate value of the coefficient of eddy viscosity. It was stated that such a simple method cannot be used for surges experienced in the Thames, since the surge has three main contributions: one from local winds, one from winds over the North Sea, and one from a surge propagated inwards from the north of Scotland and travelling around the North Sea in an anti-clockwise direction. The latter contribution is a passing wave, and its rate of decay cannot be ascertained from observations at a single place, such as are applicable in studying the decay of an oscillation of the sea itself. The removal of such an external effect and the allowance for periodic variations in the winds are necessary before the data can be utilized for the desired constants.

Mathematical formulæ for the oscillation of the sea under the influence of a variable wind were described. These involve the free period of the sea and the eddy viscosity. After the wind dies down, there is a decaying oscillation with the free period, which was quite accurately determined from a large number of surges as 30 hr., and the ratio of the first positive amplitude to the next negative amplitude was shown to be approximately 4, so that the decay is very rapid. Very precise figures could not be given because of the complexity of the phenomenon, but it was shown that the mathematical formulæ were justified only on the assumption of no bottom current; the alternative of finite bottom current would require unduly large current velocities. The decay factor corresponds to a coefficient of eddy viscosity of about 1,300 C.G.S. units.

The relation between wind velocity and elevation, with the damping factor of 4, with certain assumptions as to the effective length of channel over which it operated, gave a stress coefficient of 0·0023 C.G.S. units. This is in good agreement with values obtained by other investigators, and showed that the various results derived from the investigation were in conformity with one another. The need for caution in deducing constants from observations uncorrected for all possible oscillatory causes was fully evident.

There was unfortunately very little opportunity for discussion.

THE KAURI TREE IN NEW ZEALAND

AN article dealing with the controversy over the question of the preservation of the famous kauri tree of New Zealand, with particular reference to the treatment and control of Waipoua Forest, was published in *Nature* of January 10, 1948. The article ended on an optimistic note, as it was felt that it should not be difficult to reach agreement. Unfortunately, that agreement has not been reached,

mainly as one side feels unable to accept any compromise and appears convinced that nothing short of constituting the whole 40,000 acres a national park of the type in which nothing may ever be touched would meet requirements.

The latest development is the private publication by Mr. W. R. McGregor of an attractive booklet on the Waipoua Kauri Forest*. In producing this account, Mr. McGregor has done a real service to the wide public in New Zealand and the world over that is interested in the preservation of the best examples of natural vegetation still available for the enjoyment and study of future generations. He has a ready pen, and his descriptions reveal a deep love of the wild forest and an almost fanatic desire to exclude any activity in or near it that may threaten its wildness and solitude. The book is, moreover, profusely and excellently illustrated with fifty-six photographs. No attempt is made to disguise the fact that the author regards the State Forest Service as 'Enemy No. 1'. Indeed, perusal of the book leaves one with the impression that the object of its publication is to try to win popular support for bringing pressure to bear on the Government to withdraw the forest completely from control by the Forest Service and to constitute the whole of it a national park under some other authority on the lines adopted in Canada and the United States. This attitude leads to various charges against the Forest Service which one is reluctant to accept literally, and which, indeed, would be indignantly rebutted by the professional forester the world over.

Like any other Government Department, the Forest Department is the servant of the State, responsible for carrying out the policy of its Government, and Mr. McGregor is clearly on firmer ground when he charges (p. 11) the New Zealand public with "complete failure to develop a forest policy adequate to the needs of this country". It is rightly pointed out that the will of the people should determine the use of public land, and the reasons are marshalled why this particular area should be reserved, not for commercial forestry but as a strict Nature reserve in which no human interference with the natural processes of growth, decay and replacement should be permitted.

The reader is also reminded that ever since the original reservation of Waipoua in 1885 there have been various clear indications that those in responsible positions have viewed the forest as such a reserve. Thus Massey declined to sanction the construction of the public road which now traverses the forest, and, even when in 1926 it was built, the then Prime Minister gave assurances that timber would not be cut, and that the object of the road was only to give access for the public to see the kauri.

We understand that even the much maligned Forest Service has agreed that selected areas of the best kauri-bearing forest, as well as a strip all along the highway and individual trees of outstanding interest, should be excluded from forest management; and the real issue seems to be that of the precise extent of the desired Nature reserve. Mr. McGregor claims that the whole forest (about 40,000 acres, 27,600 being under forest) must be constituted a complete Nature sanctuary to safeguard the kauri, and he will contemplate no compromise. He gives no grounds to substantiate this claim except in the vaguest terms, and intense distrust of the Forest Service seems his strongest argument. Some of these charges are patently biased, while the pen-picture of the managed forest (p. 78) reveals a surprising ignorance of modern forestry objectives and practices.

The constitution of large national parks by Canada and the United States is quoted as a precedent to be followed, and it is urged that New Zealand should constitute such a park to save for future generations the last virgin kauri forest of New Zealand. The former countries have, indeed, many millions of acres of national parks, much of them under forest, in which no fellings are allowed (except for insect-infested or fungus-attacked trees); but they also still have vast extents of productive forests, so that the position is entirely different. The Waipoua proposition, however, clearly needs careful examination, action being stayed in the meantime to leave all possibilities open. The thesis is readily acceptable that though the kauri itself is the outstanding species to be preserved, it is unlikely that this aim can be achieved without equally protecting the native vegetation types with which the kauri is associated, particularly as knowledge of their life-history is still extremely slight. Clearly the areas selected for the preservation of the existing giant kauri should be of such extent as to include adequate samples of the other natural forest communities, some of which may be found to alternate in time with those in which kauri is now present. It can also be accepted that the amount of timber which could be obtained from Waipoua is not of great importance, either as a contribution to the total supply or specifically as special-purpose timber.

It may well be decided that to guarantee the safety of the kauri and preserve the associated vegetation it is not necessary to withdraw 40,000 acres from timber production; but early and full examination of the whole matter by a fully representative committee or commission is urgently needed. If, on the basis of its report, the country, through its elected representatives, decides in favour of the Nature reserve or national park project for a part or the whole of the forest, there should be no further hesitation in declaring that to be the decision, and so end the controversy. It may be instructive to note the action which has been taken by the State of California to preserve the redwoods along the comparatively new Redwood Highway, where relatively small blocks of forest, from a few to a few hundred acres, have been reserved or acquired in one way or another and constituted State parks. The species is adequately preserved in the surrounding forests which are under felling and regeneration by the State or private owners, the special steps being required only for the preservation of outstandingly fine trees or groves easy of access to the public.

There is also an interesting comparison to be made with the proposal now before the public in Great Britain that the State foresters should be empowered to take appropriate action to preserve and ensure the perpetuation of the oldest parts of the New Forest. These remnants are in real danger of disappearance because the requisite powers are at present lacking. In undertaking this task, the Forestry Commission would have no prospect of any financial return but only of additional expenditure.

H. G. CHAMPION

* The Waipoua Forest: the Last Virgin Kauri Forest of New Zealand. By W. R. McGregor. Pp. 80. (Auckland, N.Z.: The Author, Department of Zoology, University College, 1949.) 5s.

OBITUARIES

Mr. J. H. Coste

JOHN HENRY COSTE died on January 3 at his home at Smallfield, near Horley, Surrey, in his seventy-eighth year. His death further reduces the dwindling number of old Finsbury Technical College students, for it was at this College during 1888–91 that he received, under Meldola, scientific training which served him in such good stead for a long and most useful life. He obtained his first appointment under John Augustus Voelcker, and three years later joined the staff of the Chemical and Gas Testing Department of the London County Council; he remained in this service until his retirement in 1936. His ability was soon recognized, and in 1908 he was appointed chief assistant and in 1912 promoted to the position which is now designated Chemist-in-Chief, Public Health Department. He was always a keen experimenter, and scientific literature, mainly *The Analyst* and the *Journal of the Society of Chemical Industry*, contains no less than fifty papers of which he was either the author or part author. A perusal of these contributions shows him to have been a very versatile worker, for the subjects include petroleum, paint, water, air, milk, coal, sewage, etc., and in addition he was the author of one and part author of two books, on the calorific power of gas, the chemistry of paint pigments and on fuel.

Necessarily the field of his activities was very wide, as covering the scientific aspect of all the work of the premier local government authority in the world. In his later years his chief interests centred in two matters intimately connected with public health, namel , atmospheric pollution and sewage treatment. He was a member of the original research committee of the Meteorological Office on the former subject, that work being transferred later to the Department of Scientific and Industrial Research. After his retirement he was still active in this field right up to the time of his sudden death. Naturally, too, as a successor to the pioneers W. J. Dibdin and Frank Clowes as the senior chemist in the London County Council's service, he was intimately concerned with the sewage disposal problem, and did original work on this subject and its related one of water pollution.

Mr. Coste was a fellow of the Royal Institute of Chemistry and of the Institute of Physics, and served for periods on the council of the former and also on that of the Society of Public Analysts.

His nature was kindly and he was always approachable and willing to help in any problem, official or personal, which was put to him. His sudden passing is a great loss to the many who were privileged to be counted among his friends. C. J. REGAN

Prof. Egon von Schweidler

EGON RITTER VON SCHWEIDLER, formerly professor of physics in the University of Vienna, died on February 12, 1948, in his country home near Salzburg. His death has not hitherto been recorded in *Nature*.

Schweidler's name is familiar to all workers in radioactivity as the co-author of a manual of radioactivity which surpasses the well-known French and English standard works in this field by the range it covers and the completeness of its documentation; the two editions of 1916 and 1927 have been most valuable to generations of physicists and chemists. It was written in collaboration with St. Meyer, with whom Schweidler's name is linked also in numerous experimental papers on radioactivity. Another field in which he worked as an experimental physicist and was an acknowledged authority is atmospheric electricity.

It was, however, a contribution to theoretical physics by which Schweidler exerted the strongest influence on the development of science. At the International Congress on Radiology held in Liège in 1905, he read a paper in which he gave the statistical interpretation of Rutherford and Soddy's law of radioactive disintegration. He showed that the statement that, per unit of time, it is always the same fraction of a radioactive substance which disintegrates, can be true only if the law of large numbers makes its levelling effect felt and obscures the deviations; but these must become obvious as soon as the number of atoms under observation is reduced sufficiently. These 'Schweidler fluctuations' were soon verified by experiment, and thus the chance character of the process of disintegration directly demonstrated.

This erratic behaviour of single atoms seemed in 1905 to be something completely out of step with the rest of physics and confined to radioactive disintegration. However, in 1917 Einstein used an analogous interpretation of the emission of light from an excited atom, and it is well known what a predominant role statistical interpretations now take in quantum mechanics. The credit must go to Schweidler, however, for having recognized the first case in a fundamental paper which, in his history of physics, von Laue calls "a step forward of incalculable importance".

Schweidler was born in Vienna on February 10, 1873; he was a student, a lecturer, and an assistant professor there before he was called to the chair of physics in Innsbruck. This he occupied from 1911 until 1926, when he returned to Vienna as director of one of the physics institutes there. This position he held until his retirement in 1939. He was a member of the Vienna Academy of Sciences and for several years also general secretary and vice-president.

The atomistic school of Vienna, famous for such names as Loschmidt and Boltzmann, has lost in Schweidler another worthy representative.

F. A. PANETH

Mr. G. P. Farran

GEORGE PHILIP FARRAN, who died at his home at Templeogue, Co. Dublin, on January 5 at the age of seventy-two, was connected for nearly fifty years with the Fisheries Branch of the Department of Agriculture there. After a distinguished career at Trinity College, Dublin, he joined the small group of scientific men working, under the late Ernest W. L. Holt, on fishery and marine biological problems in Ireland; and afterwards, in 1900, he entered the service of the Department of Agriculture and Technical Instruction as a naturalist. In 1938 he was promoted to chief inspector of fisheries, a post from which he retired in 1946.

Farran's early papers had ranged over a wide field; but later in life he more or less restricted his activities to the study of planktonic organisms, particularly copepods, and the Irish herrings. As a planktologist he was a recognized authority. For a period of more

than twenty-five years he represented Ireland at the annual meetings of the International Council for the Exploration of the Sea. He was elected to membership of the Royal Irish Academy in 1912. A year ago he was elected an honorary member of the Challenger Society for his work in marine biology, and shortly before his death he was preparing to attend one of the joint meetings of the Society in London.

We regret to announce the following deaths:

Mr. W. C. Chesterman, O.B.E., assistant secretary of the University Grants Committee, on January 29, aged fifty-nine.

Dr. F. H. A. Marshall, C.B.E., F.R.S., formerly reader in agricultural physiology in the University of Cambridge, on February 5, aged seventy.

NEWS and VIEWS

Physics at the National Research Council, Canada: Dr. G. Herzberg

Dr. Gerhard Herzberg has been appointed director, Division of Physics, National Research Council, Canada, in succession to Dr. R. W. Boyle, who retired in October 1948. Dr. Herzberg is a Canadian citizen who has been on the staff of the Division of Physics for some months as a principal research officer, having gone to this post from the Yerkes Observatory, University of Chicago, where he had been professor of spectroscopy for nearly three years. During the preceding ten years, he was research professor of physics at the University of Saskatchewan, Saskatoon, Sask. Before that, he had worked in Germany at Darmstadt and Göttingen, and in the University of Bristol. Dr. Herzberg is a leading authority on spectroscopy and molecular structure, and is the author of three standard textbooks and numerous scientific papers. At Saskatoon he established a spectroscopy laboratory for graduate research and thus greatly strengthened the graduate school in physics and chemistry. He and his coworkers made important contributions to interpretation of data on spectral lines of distant stars and of comets. These investigations led up to his work at the Yerkes Observatory, where he built the world's longest multiple optical path (5,000 m. at atmospheric pressure) for the study of planetary atmospheres and to gain information on molecular structure. Using this equipment, he carried out important work on the infra-red absorption spectra of hydrogen, which has made it possible to detect hydrogen in planetary atmospheres. Dr. Herzberg will continue his varied researches in his new post.

Dr. L. E. Howlett, M.B.E.

Dr. Leslie E. Howlett has been promoted to be associate director of the Division of Physics, National Research Council, Canada. Graduating in mathematics and physics in the University of British Columbia in 1927, he went to the University of Toronto as a research fellow, proceeding eventually to McGill University for his doctorate. Since 1931 he has been on the staff of the National Research Council in charge of the optics section. During the War he aided in the development of the optical instrument industry, for which he was awarded the M.B.E. in 1943. He served as chief scientific liaison officer in London and later in Washington. Since July 1948 he has been assistant director of the Division, and his advancement to the post of associate director is a tribute to his success in the organisation and management duties entrusted to him.

Another Big Sunspot

Misty or foggy conditions in Britain on February 4 made it possible to see with the naked eye a big group of sunspots that had grown rapidly after February 1. Another factor which contributed to its 'discovery' by many members of the general public was the favourable position of the spot group near the centre of the disk. At central meridian passage on February 5·4, the group passed within 2° of the centre of the disk, and its area was then greater than 2,000 millionths or 1/500 part of the sun's hemisphere. Although in size the present sunspot was only about half that of the four giant spots seen in 1946–47, it has attracted more general interest, because of the recent atmospheric conditions for its easy visibility, and also because of the earlier big spot group of comparable size a fortnight earlier, with the associated auroral display on January 24–25 (see *Nature*, February 5, p. 203). Observers of the setting sun, seen through the London mist on February 4, could also pick out with the unaided eye two other spots.

Government Expenditure on Universities in England

In a written Parliamentary reply to Mr. Kenneth Lindsay on January 18, Sir Stafford Cripps, the Chancellor of the Exchequer, said that the non-recurrent payments to the Universities in England during the years 1945–49 were as follows: 1945–46, £620,895; 1946–47, £566,996; 1947–48, £1,920,508; 1948–49 (to January 14, 1949), £1,980,686. The principal projects covered by these grants are the purchase of sites and buildings, the erection of new buildings (including new teaching blocks for science and technology and halls of residence) and the provision of new equipment. The amounts paid to individual institutions have varied according to the opportunities for building and the degree of expansion of numbers in an individual centre. Sums in excess of £200,000 are listed as follows: University of London, £1,283,348; University of Durham, £504,011; University of Nottingham, £319,083; University of Birmingham, £292,485; University of Leeds, £270,418; University College of Hull, £240,813; University of Bristol, £230,521; University of Oxford, £217,507; University of Reading, £215,645; University College, Leicester, £213,902.

The Oil Position in 1951

Middle East oil is again prominent in the American Technical Press, this time in a paper entitled "The Place Middle East Oil will occupy in World Markets", read by C. J. Bauer, of the Standard Oil Company, New Jersey, at the annual meeting for 1948 of the American Institute of Mining and Metallurgical Engineers. As is now generally appreciated, the function of Middle East oil, once pipe-lines to the Mediterranean are completed, will be to relieve the strain on western hemisphere petroleum resources, that is to say, the United States and Caribbean region, from which at present most of West European

oil is derived. The year 1951 appears to be the crucial factor; by then it is anticipated that the annual world demand will be about 140 thousand million Imperial gallons. This will require new capital investment in the industry of £2,500 million before that year. Consumption is estimated by 1951 in the ratio of 6·3 million barrels per day for the United States as against 4·4 million for the rest of the world; in other words, there should be more petrol available for the so-called Marshall Plan countries which, unhappily, at present constitute the largest petroleum-deficient area in the world. By the same tokens, it is anticipated that the United States will practically cease to export oil and oil products to Europe by 1951, the Caribbean and Middle East regions then being the main sources of supply for Europe. The author stresses the recognition of the four great oil regions of the world, East Mediterranean basin, the Caribbean basin, the Far East basin and the North Polar basin; nowhere else are future oil supplies of magnitude likely to be found. Taking the long view, the bulk of Middle East supplies are destined for Europe; the Caribbean will furnish the major part of oil supplies to the western hemisphere; Asia, Australia and New Zealand will draw mainly on the Far East basin (when rehabilitated); and the North Polar basin, not yet in production, is destined to supply both North America and Russia. This is a far-sighted review of the world's oil situation, and it is presented in a form which, aided by extremely informative diagrams, is readily understandable to the layman. Copies of the paper may be obtained on application to the Anglo-American Oil Company, London.

Science Co-operation Office, Middle East

THE Science Co-operation Office, Middle East, of Unesco, in Cairo publishes a list of the scientific papers received at the Office; List No. 2 includes the titles of papers received during March 1–July 31, 1948, in addition to those received from January 1, 1947, and given in the previous list. The titles are again arranged under fourteen headings, the bulk of the entries falling under mathematics (2 pages), chemistry (2), geology and geophysics (2), zoology (2), medical sciences (27), engineering sciences (3), and agricultural science (5). Those under medical sciences are further subdivided and fall chiefly under physiology, biochemistry and pharmacology (3–4 pages), medical microbiology and hygiene, parasitology (4), internal medicine and surgery (5) and dermatology and venereology (2). A list of periodicals and serials normally received, arranged by countries, is also included.

A New Mechano-Electrical Transducer

RECENTLY the U.S. National Bureau of Standards has announced the development by W. A. Wildhack of a new highly sensitive mechano-electrical transducer in which small mechanical displacements are transformed into large changes of resistance, current or voltage. Displacements as small as 10^{-8} in. can be measured directly without the use of auxiliary electrical amplifying devices. A nickel-alloy wire, chosen because of its high resistivity and small change in mechanical properties with temperature, is coiled into a close helical or conical spring such that the initial tension varies along its length. Thus, when the ends of the spring are pulled apart, the turns separate one by one, the electrical resistance varying from that with the spring completely closed (approximately a cylindrical metal tube) to that with the spring entirely open (total uncoiled length of wire). The spring transducer is a very sensitive means of conversion, for any small stretching of the spring results in a correspondingly large change in resistance. Used in combination with other transducers, or in a four-arm bridge of which each arm is a spring-transducer, the new transducer should have many scientific and industrial applications.

Wild Birds and the Land

INCREASING interest in wild bird life, both from the economic and natural history points of view, has led to the publication of a bulletin under the above title by the Ministry of Agriculture and Fisheries (H.M. Stationery Office. 2*s*. 6*d*.). The bulletin has been prepared by F. Howard Lancum, advisory ornithologist to the Ministry, who has brought together a large collection of fine photographs by some of Britain's leading bird photographers. Each of the fifty species illustrated is accompanied by a note on its physical characteristics and behaviour patterns, along with a statement on its economic significance where this is known. A concluding chapter on the use and method of constructing nest-boxes and bird-tables adds to the value of a publication which could only be published at its present price on behalf of a Government department.

Fossils at the British Museum (Natural History)

THE Department of Geology in the British Museum (Natural History) has now resumed publication of the interesting and informative series of guide-books that were issued at intervals in pre-war years. The exhibition galleries were largely dismantled at the beginning of the War, and the Museum itself was afterwards severely damaged by enemy action. The re-assembling of the exhibits, and the execution of plans for re-arrangement already made in 1938, will require a long time to complete. Meanwhile, as a first step, an exhibit has been set out which is intended to serve as an introduction to the study of fossils. The fossils are stratigraphically arranged, and epitomize the succession of life through geological time. The exhibit also shows how fossils reflect past conditions, and suggests how the various forms of life developed and reacted one on another in diverse environmental associations. The new guide-book, which is primarily intended to be used in conjunction with the exhibit, is entitled "The Succession of Life through Geological Time", the authors being K. P. Oakley and Helen M. Muir-Wood. It is priced at 2*s*. 6*d*., consists of 92 pages, and includes an adequate number of well-executed black-and-white drawings and four palæogeographical maps. There is also an attractive colour plate, figuring, in natural surroundings, a reconstruction of one of the first birds, *Archæopteryx*, the unique specimen of which, from the Jurassic Limestone of Bavaria, is on exhibit in the Museum. Allowing for the increased costs of production, the price is very modest, and the guide might well prove useful as a supplement to the more orthodox elementary text-books of geology.

Bedfordshire Natural History Society and Field Club

THE original Bedfordshire Natural History Society and Field Club was founded in 1875 with fifty-nine members, and its proceedings were published in three volumes covering the years 1875–84. The Society ceased to exist about ten years later, and no record exists to show why a Society that held such promise

should have ceased to function after such a short life. In October 1946 a new county Society was formed under the old name. The reports for 1946 and 1947 indicate that the Society has made a good start under Mr. Oliver Pike's presidency and should soon gain its rightful place among similar county societies in Britain. Copies of the Society's journals may be obtained from 11 The Avenue, Flitwick, Bedfordshire.

Breeding of Locusts for Research and Instruction

THE supply of living animals for both teaching and research purposes is a perennial problem for zoological laboratories. The new insecticides are partly responsible for the difficulty which has occurred in recent years in obtaining adequate supplies of cockroaches. For many purposes the locust can take the place of the cockroach, and it has the advantages of being larger, easy to rear in laboratory conditions and, for such a large animal, it has a very rapid life-cycle; the whole life-cycle takes about seven weeks, and only about half that time is required from hatching to the emergence of the adults. Instructions for the breeding and rearing of locusts have now been prepared by the Anti-Locust Research Centre, and copies can be obtained from the Director of the Centre, British Museum (Natural History), London, S.W.7. The Centre is not prepared to sell locusts to anyone, but it will supply them free for certain research projects and, so far as possible, for starting stocks for teaching purposes; adults for class dissection will not be sent.

The Physical Society: Annual Exhibition

THE Physical Society's Annual Exhibition of Scientific Instruments and Apparatus will be held during April 5–8, 1949, in the Physics Department of the Imperial College of Science and Technology, South Kensington. The sessions during which the Exhibition will be open are: April 5, 2–9 p.m.; April 6, 10 a.m.–1 p.m., 2–9 p.m.; April 7 and 8, 10 a.m.–1 p.m., 2–7 p.m. During the Exhibition the following discourses will be delivered: "Some Problems of Wave Diffraction in the Ionosphere", by Mr. J. A. Ratcliffe; "Some Modern Aspects of Scientific Instruments", by Mr. A. J. Philpot; "A Review of the Methods and Instruments used in Energy Measurements of Particles in Atomic Nuclei", by Prof. O. R. Frisch. A film on the liquid idophor or teleidoscope will be shown. The Exhibition will also display entries for the craftsmanship and draughtsmanship competition, which is being revived after a lapse during the war years. This competition is organised to encourage and give recognition to skill and ability in craftsmanship and draughtsmanship among apprentices and learners in the instrument-making industry, and a large number of firms and technical institutions is supporting it. The prize-winning entries will afterwards be shown in the Science Museum at South Kensington.

Management Bulletin

FROM December 1948 the British Institute of Management has been issuing to members and subscribers a *Management Bulletin* concerned with events in the management field as a whole. The first issue includes a list of forthcoming events as well as papers arranged by the Institute for February–May, 1949, with brief notes on the activities of the education department, examinations department and the information and research department, and a list of recent additions to the library. Suggestions and criticisms with regard to the scope and utility of the *Bulletin* are invited.

Seventh Pacific Science Congress

THE Seventh Pacific Science Congress (see *Nature*, September 11, p. 409) is now in session in New Zealand. Thirty countries are participating, and of these the seventy-one United States representatives form a particularly large delegation. These American men of science are representing not only the United States but also the dependent territories, such as the Pacific Islands and Honolulu, and the occupation authorities in Japan. British and American civil air-lines and also the United States Military Air Transport Service have made special arrangements to fly these American delegates from their respective scattered locations to New Zealand. The Royal Society has sent a delegation of six to the Congress (*Nature*, January 1, p. 17).

Announcements

PROF. PIERRE-PAUL GRASSE has been elected a member of the Section of Anatomy and Zoology of the Paris Academy of Sciences, in succession to Dr. Robert Courrier, who has become one of the permanent secretaries of the Academy.

THE Institute of Metals Medal (in platinum) for 1949 of the Institute of Metals has been awarded to Dr. William Hume-Rothery, lecturer in metallurgical chemistry in the University of Oxford, in recognition of his outstanding contributions to the science of non-ferrous metallurgy.

PROF. F. F. NORD, of the Department of Organic Chemistry, Fordham University, New York, has been awarded the 1949 Carl Neuberg Medal of the American Society of European Chemists and Pharmacists.

PROF. K. S. DODDS, head of the Department of Botany and Genetics at the Imperial College of Tropical Agriculture, Trinidad, has been appointed principal scientific officer of the Empire Potato Collection, Commonwealth Bureau of Genetics, Cambridge.

MR. W. K. B. MARSHALL has been appointed assistant director of research of the British Welding Research Association. Mr. Marshall is well known for his work on light alloy and stainless steel welding, and in his new position he will pay particular attention to non-ferrous welding research.

THE officers for 1949 of the Nairobi Scientific and Philosophical Society (see *Nature*, October 23, p. 647) are: *President*, V. A. Beckley; *Vice-Presidents*, Dr. B. A. Keen, Dr. R. M. Dowdeswell and H. E. Watson.

THE Institute of Navigation has arranged a symposium on "Operational Aspects of Marine Radar", to be held at the Royal Geographical Society on February 18, at 2 p.m., under the chairmanship of Sir Robert Watson-Watt. Papers to be presented include two from the U.S. Institute of Navigation. The meeting is open to non-members.

THE W. H. A. Robertson Medal and Premium will be awarded annually by the Institute of Metals to the author or authors of the best paper contributed to the *Journal of the Institute of Metals* on engineering aspects of non-ferrous metallurgy. For the first award, papers published in the Institute's *Journal* from March 1948 to August 1949, inclusive, will be considered.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Influence of Cosmic Radiation on Experimental Tuberculosis

THE results of two series of experiments on the action of cosmic radiation on experimental tuberculosis in mice are reported below. In the first series, eighty mice were injected intravenously in Leyden (sea-level) with 1 mgm. of tubercle bacilli and transported four days later to the Jungfraujoch (3,457 m.).

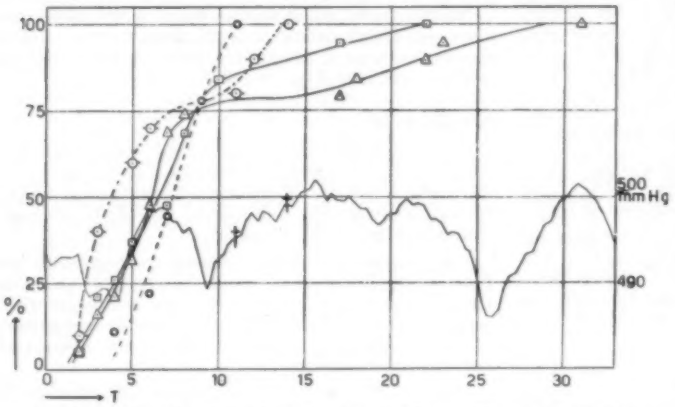

Fig. 1. Mortality curve. *T*, time in days after treatment; △, mice kept in daylight; □, mice screened from cosmic radiation; ○, mice exposed to direct cosmic radiation; —⊙—, mice exposed to cosmic radiation with 2 cm. of lead

One group was exposed to the direct action of cosmic radiation, a second group was placed under 2 cm. of lead, which gave the maximum intensity of showers, a third group was screened from cosmic radiation, and a fourth group was exposed to daylight and ultra-violet light down to 3,300 A., being thus subjected only to the hard component of the cosmic radiation. The first three groups were placed in a room without daylight, illuminated by a 40-watt electric lamp.

Fig. 1 represents the cumulative mortality curve. The beneficial effect of screening from cosmic radiation can be seen by comparing the curves for mice exposed to cosmic radiation with that for mice screened from cosmic radiation. The beneficial effect of daylight and ultra-violet light can be seen by comparing the curve for mice exposed to daylight with that for mice exposed to cosmic radiation, and that for mice screened from cosmic radiation. By statistical methods, it has been shown that there is no significant difference between the mean times of survival, but there is a significant variation from uniformity of mortality among groups treated alike ($P < 0{\cdot}001$). The different groups of mice are thus not from the same population. The weight of the mice exposed to cosmic radiation with and without absorber is significantly higher than that of the mice screened from cosmic radiation. The last curve has the same form as that of the mice exposed to daylight.

Two of the mice exposed to cosmic radiation with 2 cm. of lead developed severe intestinal hæmorrhage; it will be seen from Fig. 1 that these mice died when the barometric pressure was increasing. The mice exposed to direct cosmic radiation showed tremblings during the last weeks, one of them dying with extreme abdominal ascites. It is important to note that three of the mice exposed to cosmic radiation with 2 cm. of lead absorber had only a few tubercles in the lung, whereas all the other mice showed severe lung tuberculosis.

In the second series, sixty mice were injected intravenously with 0·7 mgm. of tubercle bacilli at the Jungfraujoch (3,457 m.). The tubercle bacilli were thus immediately in contact with low oxygen tension in the lung (60 mm. mercury). It has been shown independently by Rich and Follis[1] and Ong, den Dooren de Jong and Schornagel[2] that the histological lesions are markedly inhibited and the mean time of survival is significantly prolonged, when tuberculous mice are kept in an oxygen concentration below 10 vol. per cent. In the early stages of dying, only a few tubercles were found in the lung, but there were tuberculous lesions in the spleen, kidney and liver. In the later stages, we observed severe lung tuberculosis with small or no lesions in the organs, and in these cases there was anoxia and thus the oxygen supply in the body tissues was insufficient. This diminished the lesions in the organs.

There were four groups in the second series: mice kept in artificial light screened from cosmic radiation, mice kept in artificial light exposed to direct action of cosmic radiation, mice kept in artificial light placed under 2 cm. and 10 cm. of lead. As in the first series, we observed hæmorrhages among the mice exposed to cosmic radiation. The hæmorrhages were from the genital organs, mouth, intestines and rupture of the spleen. Three of these mice died during the ascending phase of the barometric pressure and two in the descending phase. As the intensity of the cosmic radiation changes with the barometric pressure, and as none of the mice exposed to the same barometric pressure but screened from cosmic radiation showed any hæmorrhage, we conclude that the hæmorrhage is caused by the variation of intensity of the cosmic radiation.

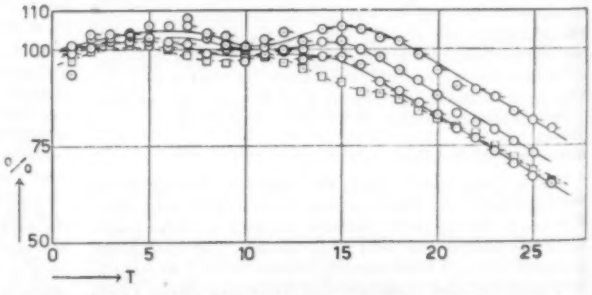

Fig. 2. Weight curve. *T*, time in days after injection. □, Mice screened from cosmic radiation; ○, mice exposed to direct cosmic radiation; ⊙—, mice exposed to cosmic radiation with 2 cm. of lead; —⊙—, mice exposed to cosmic radiation with 10 cm. of lead

There is no great difference in the form of the mortality curves of the four groups of mice. Statistical methods show no significant difference between the mean lives, but show significant variation in mortality among groups treated alike. We also conclude that the groups of mice are not from the same population.

As in the first series, the weight of the mice exposed to cosmic radiation is significantly higher than that of the mice screened from cosmic radiation (Fig. 2). Fig. 2 shows that the more the mice were exposed to the soft component and the showers of cosmic radiation, the more the loss of weight is retarded.

I am indebted to Prof. J. Clay for discussions on cosmic radiation; to Prof. D. Chalonge and Mr. F. Egger for determining the transmission spectra for ultra-violet light; to Mr. E. van der Laan for discussing statistical methods; to Dr. W. Mörikofer for the records of barometric pressure at the Jungfraujoch; also to Messrs. U. Camerini, J. A. Gay, D. Ritson and M. A. Roberts for assistance in the cosmic radiation experiments. This research was rendered possible by a grant from the Nederlandsche Organisatie voor Zuiver-Wetenschappelijk Onderzoek.

S. G. Ong

Hochalpine Forschungsstation,
Jungfraujoch,
and
Physiological Laboratory,
Leyden.

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Cross-section for the Disintegration of the Deuteron by 2·76 MeV. γ-Rays

Since our recent communication[1], calibrated sources of radiosodium have become available. In view of the high value for the cross-section for photodisintegration of deuterium with radiothorium γ-rays, we decided to repeat our measurements with a radiosodium source. At the same time, several improvements in the apparatus were made; a spherical electrode instead of a cylinder now defines the sensitive volume of the ionization chamber; this avoids the error due to low field at the corners, and reduces the γ-ray background. This improvement, and a slight reduction in valve noise, enable higher counting-rates to be used, and enable pulses of 150-keV. energy to be counted before γ-ray and noise background becomes troublesome. The shielding due to positive ions does not reduce any pulses below this energy, and the correction for this effect is zero; the wall-effect correction is also reduced (4 per cent for radiothorium source, 6 per cent for radiosodium source).

The deuterium concentration was measured at Metropolitan-Vickers Electrical Co., Ltd., with a mass spectrometer which admitted the gas through a needle valve. This obviated the palladium leak separation factor, and gave a result for the deuterium content of the samples 4 per cent higher than that obtained previously (99·2 ± 0·5 per cent deuterium). This agrees with the expected output of our electrolysis plant.

As a check upon the correct operation of the counter, the pulse-height distribution was plotted with a single-channel kick-sorter. The observed distribution was slightly wider than the theoretical distribution. This can be accounted for by positive ion effects and the change in zero due to γ-ray background. When corrections have been applied for these, the ratio of the electric to magnetic photo-effect can be deduced, for the pulse-height distribution can be related to the angular distribution by the principle of conservation of momentum. The results thus obtained are in agreement with those obtained recently in Copenhagen[3] and with other results[3].

A further check is afforded by the ratio of the pulse-heights for disintegration by radiosodium and radiothorium rays. This agrees with the expected value, 1·32, different determinations giving 1·30, 1·31, 1·32, 1·37. The radiothorium source was calibrated as before, using Ricoux's result[4]. An alternative method using the less accurate results of Shenstone and Schlundt[5] would yield a 3 per cent higher value for the cross-section; so also would a method based on the total ionization from radiothorium γ-rays[6], coupled with a knowledge of the γ-ray energies and relative intensities[7]. An aliquot from the sodium source was calibrated at the Atomic Energy Research Establishment, Harwell, by Mr. Putman and Mr. Willment, using a β-γ-coincidence method[8]. The β-spectrum is single[9] and is followed by a 2·76-MeV. and a 1·38-MeV. γ-ray in cascade for every disintegration. There is not more than 1 per cent of β-rays of 2·76 MeV. or higher energy[10]. An intercomparison between their calibration and results using a small graphite-walled ionization chamber has been made by Gray[6], and they agree to within 2 per cent. Altogether, the radiosodium calibration seems to us less subject to doubt than the radiothorium calibration.

Any γ-rays from forbidden lines (RdTh 3·2 MeV. and Na^{24} 4·14 MeV.) would produce more energetic photoprotons. These have been looked for, and upper limits of one part in one thousand and one part in ten thousand respectively can be assigned to these transitions. The decay period of radiosodium has been redetermined as 14·90 ± 0·02 hr.[11].

The results we now present are the mean of five independent measurements; for each filling, a determination was made for both radiosodium and radiothorium; the radiothorium determinations agree within 1½ per cent, which is better than in the case of the sodium determinations, since it includes only the errors in counting, distance measurement and pressure measurement. As a different sodium source was used for each determination, the calibration errors enter into the consistency of the sodium determinations.

Radiothorium cross-section	14·8 ± 1·0
Radiosodium " "	15·6 ± 1·0
Ratio	1·05 ± 0·08

The theoretical values for the radiosodium cross-section have been kindly sent to us by Prof. Hulthén. The ratio $\sigma_{Na}/\sigma_{RdTh} = 1·21$ for a meson mass 296, and 1·22 for meson mass 197. Thus the observed ratio constitutes a certain discrepancy.

Since these measurements were made, a new value for the binding energy of deuterium has been published[12]. The cross-sections for this value (2·237 MeV.) of the binding energy are lower by about 10 per cent.

Detailed results will be published elsewhere in due course.

We have to thank Mr. K. Wood, of Metropolitan-Vickers Electrical Co., Ltd., for analysing the deu-

terium; Messrs. J. L. Putman and R. Willment, of the Atomic Energy Research Establishment, Harwell, for the calibration of the sodium source; Mr. G. R. Bishop, for his help with the measurements; and Lord Cherwell, for extending to us the facilities of this Laboratory.

R. Wilson
C. H. Collie
H. Halban

Clarendon Laboratory,
Oxford. Dec. 21.

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The Primary Soft Component of Cosmic Radiation

In a recent communication, Rossi[1] analysed burst measurements of Hulsizer[2] and concluded that if a primary soft component exists at all, it constitutes not more than a few per cent of the total primary intensity. In our opinion, Rossi's numerical interpretation of Hulsizer's results is erroneous.

Bursts were observed by Hulsizer containing a minimum of eighty ionizing particles passing through the burst chamber. The cross-section of the burst chamber was 50 cm.^{2}; it was covered by 2·5 cm. of lead. At a height 0·5 cascade units under the top of the atmosphere, 300 bursts per hour exceeding the minimum size were observed. These bursts were interpreted in the following way: (1) it was assumed that the absorption of any primary spectrum through the atmosphere above the chamber was negligible; (2) it was assumed that electrons of 4,500 MeV. can give rise to bursts of eighty particles; (3) it was assumed that half the bursts are not caused by cascade showers but by heavily ionizing particles.

Thus an upper limit for the number of electrons with energies exceeding 4,500 MeV. was derived. Comparison with the total number of incident particles led Rossi to conclude that "not more than 1 per cent of the primaries are electrons with energies exceeding 4,500 MeV.". In our opinion, the calculation requires modification.

(1) The absorption law of a power spectrum of electrons is well known; given an incident spectrum,

$$S(E;\ 0) = \frac{A}{E^{\gamma+1}}, \qquad (1)$$

at a depth of ζ cascade units, we have,

$$S(E;\ \zeta) = \{M(\gamma)\exp(-a_1(\gamma)\zeta) + N(\gamma)\exp(-a_2(\gamma)\zeta)\}\, S(E,\ 0) \qquad (2)$$

(see for details, for example, Jánossy, "Cosmic Rays", p. 237).

With $\gamma = 1{\cdot}7,\ \zeta = 0{\cdot}5,$

we find

$$S(E_1\ \zeta)/S(E_1\ 0) \sim 0{\cdot}5.$$

Thus the primary component is reduced to half its intensity under $\zeta = 0{\cdot}5$ (a fraction of this reduction is replaced by photons).

(2) An electron of 4,500 MeV. does not give rise to a shower of eighty particles. But, in any case, a large fraction of shower particles in lead have energies of a few MeV. only, and many of those will be lost by scattering. Thus it seems reasonable to assume that a shower which contains a total of, say, 160 particles, will just manage to produce 80 particles passing through the chamber.

Using the formalism of Bhabha and Chakrabarty, we find that a primary energy of about 20,000 MeV. is required to give rise to a burst of eighty particles in the burst chamber. Thus, accepting other details given by Rossi, we are led to conclude that not more than 2 per cent of the primary cosmic rays are electrons with energies exceeding 20,000 MeV.

If the cut-off of the power spectrum is taken to be at 2,000 MeV., the total number of electrons according to (1) must be less than

$$2 \text{ per cent} \left(\frac{20{,}000 \text{ MeV.}}{2{,}000 \text{ MeV.}}\right)^{1\cdot7} = 100 \text{ per cent.}$$

Thus no significant upper limit for the strength of the primary component can be derived from Hulsizer's measurements.

I would not go so far as to suggest that Hulsizer's measurements *prove* the existence of a soft component, as there are many *ad hoc* ways of accounting for the experiments. I would like to emphasize, however, that there is to my knowledge no valid experimental evidence against the existence of a primary soft component; while latitude effect and extensive air showers can most easily be accounted for in terms of a primary soft component forming a moderate fraction (say, 30 per cent) of the total primary intensity. General arguments supporting the existence of a primary soft component have been presented and discussed in detail by Ferretti[3].

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[1] Rossi, B., *Rev. Mod. Phys.*, **20**, 537 (1948).
[2] Hulsizer and Rossi, *Phys. Rev.*, **73**, 1402 (1948).
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We are glad that the critical remarks of Jánossy give us an occasion to reconsider the interpretation of our balloon experiments.

We have been aware of the fact that some of the figures quoted in our original paper are inaccurate. Indeed, in a paper presented by one of us at the Cosmic Ray Symposium held in Pasadena last June, a revised estimate of 10 BeV. was given for the minimum energy of an electron capable of producing the observed bursts[1]. We can, however, answer specifically Jánossy's remarks.

(1) Atmospheric absorption. Since our instrument is sensitive to electrons and photons alike, one has to consider the change in the total number of these particles and not that in the number of electrons alone. For vertical incidence and for a power spectrum with $\gamma = 1{\cdot}7$, the reduction factor at a depth of 20 gm. cm.$^{-2}$ amounts to 0·7. However, we must consider that the quantity measured by our instrument is closer to the integrated rather than to the vertical intensity. For the integrated intensity the reduction factor is 0·44.

(2) Energy E_0 of an electron which produces a shower of 80 particles through our chamber. The calculations of Richards and Nordheim, which have

just been published[2], show that the proportion of low-energy electrons in a shower from lead is exceedingly large. Thus Jánossy's estimate of 50 per cent for the number of shower electrons which penetrate the chamber wall appears quite reasonable, even though the thickness of this wall is only 0·6 gm.cm.$^{-2}$. However, the production of electrons in the chamber wall by photons from the lead may appreciably reduce the effective absorption. If we do not take this last effect into account, and if we apply the results given by Bhabha and Chakrabarty in their most recent publication[3], we obtain for E_0 a value of 13·5 BeV. This value is arrived at by considering electrons which travel perpendicular to the chamber axis and which traverse on the average 2·8 cm. of lead thickness. Electrons arriving at an oblique angle traverse a greater thickness of lead, and their shower particles travel a longer path in the chamber. Both effects reduce the value of the electron energy corresponding to a given burst size. The correction to E_0 for the effect of oblique incidence is not easy to compute. At any rate, it appears as if Jánossy's estimate of 20 BeV. for E_0 may be excessive, and a value of 10 BeV. such as given at the Pasadena Symposium may represent a more likely estimate.

(3) Low-energy cut-off of the primary spectrum. Balloon experiments of Millikan, Neher and Pickering[4] by means of cosmic ray telescopes failed to reveal any change of the vertical intensity at latitudes greater than 45°. This places the cut-off energy at a value higher than 4 BeV., rather than at 2 BeV., as quoted by Jánossy. (At 45° the limiting energy corresponding to the Störmer cone is 3·8 BeV., that corresponding to Lemaître and Vallarta's main cone, 6 BeV.)

On the basis of the above considerations, one would obtain from our measurements an upper limit of about 11 per cent for the number of electrons in the primary radiation. However, we are very hesitant about this figure, especially because of the great uncertainty of the shower theory for heavy elements.

In conclusion, it is our present opinion that the question concerning the existence of electrons in the primary cosmic radiation is still open and can only be settled by further experiments. One of these experiments, directed at obtaining information as to relative contributions of electron showers and of nuclear interactions to the ionization bursts observed at high altitude under lead, is at present under way.

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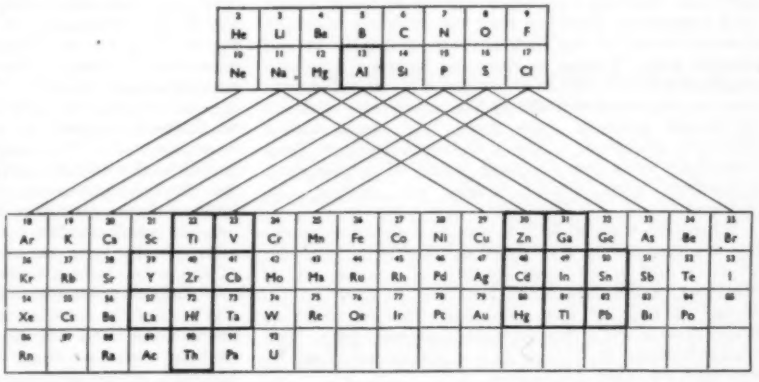
Theory of Superconductivity

In two previous notes[1], Prof. Max Born and I have shown that one can obtain a theory of superconductivity by taking account of the fact that the interaction of the electrons with the ionic lattice is appreciable only near the boundaries of Brillouin zones, and particularly strong near the corners of these. This leads to the criterion that the metal should be superconductive if a set of corners of a Brillouin zone is lying very near the Fermi surface, considered as a sphere, which limits the region in the momentum space completely filled with electrons.

It will now be shown that this theory affords an explanation of the fact that the superconductive elements lie exclusively in two columns of the periodic table. In the accompanying table they are marked in rectangular blocks, showing that they lie on either side of the so-called 'transition metals'. These metals are characterized by the fact that in going from one to the next along the periodic table, electrons begin to fill the inner zones which previously remained vacant. Thus the bordering columns must have one of the lower Brillouin zones either completely vacant or just filled; then the necessary condition of superconductivity that the Fermi surface touches the corners of a Brillouin zone will be satisfied.



Periodic table: two columns of superconducting elements, marked in rectangular blocks

From these considerations we can deduce a rule regarding the superconductive alloys and compounds. An alloy formed of two elements from different sides of the superconductive columns will have a better chance of being superconductive than any other alloy. The reason is that the lower Brillouin zone for one element is nearly filled, while for the other element it is rather more than filled, and the combination of them (obtained by forming the alloy) satisfies the requirement of superconductivity. For example, alloys like $BiAu_2$, CuS, which are formed from two elements from either side of the superconductive columns, will be superconductive themselves, though both elements are not.

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Nov. 3.

[1] *Nature*, **161**, 968 and 1017 (1948).

Thixotropic Behaviour of Petroleum Jelly

If the term 'thixotropy' be restricted to Freundlich's original definition of reversible sol–gel transformation, a peculiar manifestation of this property is strikingly shown by petroleum jelly at varying rates of shear. The phenomenon can be demonstrated with no more elaborate apparatus than a 100-c.c. glass cylinder and a perforated disk as piston, mounted centrally on a metal rod terminating in a ring, a similar arrangement to the familiar 'malted milk mixer'. The plunger not only serves to shear the contents of the cylinder, but also as a rough consistometer, the time of travel of the disk between any two graduations on the freely suspended cylinder serving as a measure, provided the rigidity component of consistency of the material is less than the hydrostatic load of the suspended cylinder.

A petroleum jelly of medium consistency serves for the observation. This should be melted, poured into the cylinder and allowed to set for 24 hours, when the consistency will be generally such that no movement of the disk relative to the jelly takes place when the apparatus is suspended by the ring.

If now the plunger be worked up and down very slowly between its lowest position and, say, the 25 c.c. mark, the shearing resistance will be felt to diminish until suspension from the ring will result in a steady upward travel of the disk through the jelly in the sheared zone. Timing is recorded between any two graduated points within the zone of shear. Measurement is repeated by *slowly* returning the disk to its lowest position once more and again noting the time of travel. Repeated measurements lead eventually to a low constant value of consistency, increasing very slowly indeed on resting the material.

When this sheared jelly is now re-sheared by pushing the plunger up and down as quickly as possible, a rapid and progressive growth of consistency is observed, a few churnings resulting in such an increase of rigidity that the disk remains fixed in position as it did in the original unsheared jelly. The transformation from high to low consistency may be repeated as often as desired.

The optical picture is not very clear. The unsheared material shows thin needle-shaped crystals under polarized light, but rather less in amount than the known heterogeneity would lead one to expect. This may, of course, be due to the bulk of the crystals being of a dimension below optical resolution. The field under paraboloid condenser illumination is quite void, indicating similarity of refractive indices of the component phases. The slowly sheared jelly under polarized light shows a great increase of crystallinity, the crystals, however, apparently having the form of shorter, thicker double cones on a common base. The quickly sheared material again shows needles, but of a shorter length, and, while the field of the original jelly shows some incomplete rosettes, these are here absent.

These experiments followed on qualitative observations on a sample of petroleum jelly which had been variously treated by the alternative methods of melting and quickly chilling to a low and a normal temperature respectively, passing through a three-roller mill, a cone mill, a milk homogenizer and a Werner–Pfleider mixer, the subjective consistencies being in the descending order named.

Precision measurements of mobilities by a capillary plastometer and of rigidities by a parallel plate plastometer are in progress of determination.

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Sept. 3.

Recrystallization of Metals under Stress

In *Nature* of September 11, 1948, Prof. E. N. da C. Andrade and also Messrs. Sully, Cale and Willoughby discuss the recrystallization of metals under stress. This phenomenon has been under observation[1–3] in the Metallurgical Laboratories of the University of Melbourne for some fourteen years; and we have reached the following conclusions relating to lead and its dilute alloys.

(1) Industrial virgin lead, so long as it contains less than 0·001 per cent silver, will, in the annealed state, recrystallize under stress when it has reached 4–5 per cent elongation at strain-rates of the order of 10^{-4}–10^{-3} per day. (2) In the 'as rolled' condition, the recrystallization frequently occurs with less than this amount of deformation. (3) The recrystallization is always accompanied by an increase in grain size, the linear dimensions of the grains increasing by a factor of ten. (4) There is a marked increase in creep-rate during recrystallization. (5) The recrystallization starts at one or more centres and spreads throughout the mass. It can be observed at different stages by intercepting the test and re-etching. (6) The progress of recrystallization can be followed without interrupting the test by observing the slip-line system on the test piece. At first, slip lines change direction at the boundaries of the original small crystals; after recrystallization in any area the slip lines are seen to continue across many of the areas defined as crystals by the original etch. (7) Annealing lead at 120° C. for 24 hours removes the facility for recrystallization at creep-rates of the above order. (8) The phenomenon is noted in alloys of lead with less than 0·05 per cent copper, zinc, bismuth, silver, antimony, respectively. In general, the strain needed is higher: an alloy containing 0·001 per cent silver recrystallized after 10 per cent extension in 300 days caused by a load corresponding to an initial stress of 500 lb./sq. in. (9) Additions of less than 0·05 per cent of calcium, magnesium or tellurium respectively appear to eliminate the recrystallization under the conditions used. (10) In pure lead, vibration facilitates recrystallization. With a creep-rate of 10^{-4}–10^{-3} a day, the phenomenon occurs with about 2·5 per cent elongation when a 50-cycle vibration is superposed on a steady stress.

The creep-rates employed by us have always been much lower than those reported by Prof. Andrade. In our opinion the rate of strain has a fundamental effect on the mechanism of creep.

I do not agree that the transition from constant creep-rate to accelerating creep-rate in uniform load tests is necessarily due either to the increased stress or to recrystallization at this stage, except in the case of single crystals. Hirst[4] has shown that single crystals of lead do fail in this manner.

It is interesting to note from the work in the Fulmer Research Institute that the compression –

creep curves reproduce the same features as the tensile–creep curves even though the stress is decreasing under constant load.

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Nov. 2.

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[4] Hirst, H., *Proc. Aust. Inst. Min. and Met.*, No. 118.

Planetary Aberration

The phenomenon of aberration is usually explained in text-books by considering the motion of the earth past a train of light waves. The special theory of relativity, however, tells us that only relative motions are apparent, and so aberration should occur when a light source is moving relative to an observer. In particular, stars having a component velocity perpendicular to the line of sight should produce an aberration effect. In most stars, this would not be observed, since it would be constant; but binary systems, in which one component has large velocities in its orbit, should show aberration effects. The angle of aberration is dependent only on the relative velocities, not on the distance, and has the direction of the velocity. Thus I would expects numerous observations of stars rotating about one another with large (apparent) angular separation but short period (that of average spectroscopics).

Is there something wrong in the above reasoning, or is it that the effects have been observed and not recognized as aberration effects, but included in the intrinsic orbits? Other possible reasons for not observing the effect are: (1) the spectroscopic binaries from which we deduce the large orbital velocities are not truly binaries, and some other explanation of them must be found; or (2) if none of the previous suggestions contains the answer, it would appear that an ether had been found, in which case only the observer's motion produces an effect.

Incidentally, the same reasoning applies to any star rotating on an axis nearly parallel to the line of sight—any measurement of diameter would be dependent on the linear velocity of its equator.

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Neither classical physics nor relativity supposes that the rays of light from a moving object are curved as a result of its velocity; the rays which left it at any given time can therefore be prolonged straight backwards (at any later time) until they intersect at the point which it occupied when they were emitted. If a fixed object is also at that point, any observer anywhere will thus see that at the instant of emission the two bodies coincided. Mr. Hines's difficulty has its origin in a misconception; light leaves the source in *all* directions, not in some specified direction, and although the direction of the particular ray that reaches the observer may depend on the motion of the source, some ray or other will reach him in every case; and every ray points straight back to the point where the source was at the time of emission. The argument in respect of that particular point is independent of any changes in the velocity of the source, whether before or after, and it thus applies to every point of the orbit of a binary; if the true orbit were visible as a fixed luminous wire, the star would always be seen on the wire.

Against this background, we may consider the pre-relativity treatment of aberration. In fact, the pre-relativity position already was that to the first order it is only the *relative* motion of the source and observer which matters, for aberration. The subject is treated in some astronomical text-books (for example, Newcomb, "Spherical Astronomy") under 'planetary aberration'. Relativity has extended this statement to all orders; but there is no astronomical case in which higher orders than the first are observable, so that in practice relativity has made no difference. With double stars, however, there is no advantage in considering systems of axes in which first one component and then the other is stationary; this merely introduces varying displacements of the entire binary system, and is liable to lead to confusion of the sort that has troubled Mr. Hines.

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Tissue Suspensions for Estimations of Radioactivity

The biologist has frequently to devise an appropriate method for the estimation in a liquid counter of radioactive substances contained in tissues. It is desirable that the technique should be both simple and rapid, and the final fluid medium either a solution of the substance or at least a fine, stable, homogeneous suspension of the total tissue which permits dilution and the removal of representative samples. Coarse suspensions tend to produce erratic counting-rates, due, in part, to drifting of the suspended material into zones of reduced tube efficiency; this can often be verified by shaking such a suspension in the counter after particles have been allowed to settle. In the case of such elements as the halogens, preparation from the tissues of a solution containing the radioactive compound becomes a tedious process if loss is to be avoided, and in these cases a suspension appears satisfactory.

Of the common reagents used for this purpose, solutions of potassium hydroxide are unsuitable, since it is possible to obtain, in a counter of 10 c.c. capacity, counting-rates of more than 400 per minute from the presence of the active potassium (K^{42}) isotope alone. Sodium hydroxide, on the other hand, tends to produce from tissue a troublesome gelatinous mass. Working chiefly with brominated organic compounds, I have obtained satisfactory suspensions by boiling the tissue under reflux in a solution of lithium hydroxide containing 20 per cent of alcohol, afterwards washing out the condensers with a little alcohol. Under these conditions, a suspension is rapidly produced which remains reasonably stable for some hours.

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Dec. 21.

Mepacrine Hydrochloride in the Treatment of Avian Coccidiosis

As the result of research in Great Britain and in the United States, the use of certain sulphonamides, particularly sulphamezathine, has become the standard method of treatment of acute cæcal coccidiosis of chickens caused by *E. tenella*. The successful results obtained have tended to focus the attention of workers almost entirely on this group of drugs. The purpose of this communication is to report the successful treatment of the disease by mepacrine hydrochloride.

This drug was used extensively in human medicine during the War, chiefly in the suppression of malaria and also in infestations by certain intestinal protozoa. Until recently, records of its use in animals have been confined to the Continent[1–4]; its effective use in an outbreak of bovine coccidiosis has now been reported in Great Britain[5]. In view of the successful treatment of other animals, Continental workers suggested that it might be evaluated in cæcal coccidiosis of chickens, but to the best of our knowledge no report on this work has been published.

In a preliminary experiment, forty chicks, 10 days old, were dosed with sporulated oocysts of *E. tenella*, and 24 hours later were given 0·1 gm. of mepacrine hydrochloride in 4 pints of drinking-water. The chicks were placed in a brooder and kept on a solid floor, which was not cleaned so that infection might be built up. Drinking-water containing mepacrine hydrochloride in the above-mentioned amount was given daily. Seven deaths occurred as a result of acute cæcal coccidiosis. In a control pen of forty chicks given untreated drinking water, twenty-six died from the disease.

In a later experiment, forty chicks, 21 days old, were each given a single dose of sporulated oocysts and placed in a brooder with a wire floor to prevent massive re-infestation, and given drinking-water containing mepacrine hydrochloride (0·1 gm. to 4 pints of water). Seven deaths occurred compared with twenty-three deaths in the control pen.

The drug was well tolerated; one group of chicks, 10 days old, received mepacrine hydrochloride solution in the above concentration in place of drinking-water continuously for six weeks. They drank the medicated water readily, ate well throughout the period of observation and showed no symptoms beyond a slight ruffling of the feathers. Their average weight, however, was 3 oz. less than that of a similar group of chicks given mepacrine hydrochloride continuously for three weeks, followed by ordinary drinking-water during the remainder of the experiment. The average weight of the latter group was that of normal chickens of the same age. Three weeks later, however, the weights of both groups were equal. It would appear, therefore, that even prolonged dosing has no lasting adverse effects.

Mepacrine hydrochloride is readily soluble in water, and in the very weak solution used in these experiments it is both effective and cheap. It is probable that even better results would follow a higher concentration in the drinking-water. One gram to each gallon of water is tentatively suggested; treatment to commence as soon as blood is noted in the droppings and to continue for five to seven days.

Experiments along these and other lines are proceeding, and it seems that mepacrine hydrochloride may become a most useful agent in combating avian coccidiosis, a serious disease of chickens, particularly in the event of the development of strains of coccidia resistant to sulphonamides.

Mepacrine hydrochloride in the form of free-flowing granules prepared by May and Baker, Ltd., under the trade name of 'Mecryl', was used in the experiments described, and the advice of this firm has been greatly appreciated.

J. E. Wilson

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Dec. 17.

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Chromatography of Nucleic Acid Derivatives

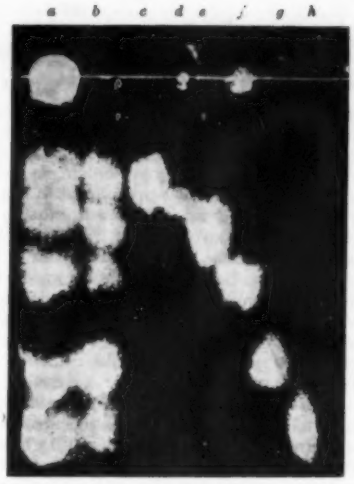
The nucleic acids and their derivatives are fundamental constituents of biological systems; but until recently workers have lacked precise micro methods for their study. Vischer and Chargaff[1], and recently Hotchkiss[2] and also Reichard[3], have shown that partition chromatography[4] may be used to separate and characterize certain derivatives. The methods employed by these workers to detect the spots on the chromatograms were, however, either limited in their scope or necessitated the analysis of a large number of fractions selected arbitrarily from the columns.

We have approached this problem in a different way. Purine and pyrimidine derivatives are characterized by an intense ultra-violet light absorption in the region of 2650 A., and they can be detected in amounts of 10 μgm. or less by a simple photographic technique.

The source of ultra-violet light used in these experiments is a quartz mercury vapour lamp (Hanovia Homesun, 200 V. D.C., 450-watt) fitted with a ventilated shield having an aperture cut opposite the middle of the tube. The light from this is filtered through two quartz filters having a free aperture of 22 mm., one 35 mm. thick, containing dry chlorine, and the other 30 mm. thick, containing a salt solution ($NiSO_4.7H_2O$, 350 gm., $CoSO_4.7H_2O$, 100 gm. per litre[5]). The light passed by these filters in the ultra-violet, mainly the 2537 A. and 2650 A. mercury lines, is absorbed by purine and pyrimidine derivatives, while the visible light transmitted has no effect on the photographic material used.

Chromatograms run in *n*-butanol in an atmosphere containing ammonia on Whatman No. 1 paper are dried and pinned on to a slightly convex cylindrical surface over a strip of Ilford Reflex Document Paper No. 50. This is then exposed at a distance of 120 cm. to the ultra-violet light for 1½ min. and developed in a process developer (Kodak *D*153), fixed, washed and dried. The absorbing substances show up on the black background as light areas (see reproduction), and the corresponding areas of the filter-paper may be cut out, extracted in water and estimated spectrophotometrically.

While the positions of the various purines, pyrimidines and nucleosides on our chromatograms agree reasonably well with those observed by Hotchkiss.



Chromatogram run for 20 hr. in *n*-butanol – water of (*a*) turnip yellow mosaic virus nucleic acid hydrolysed with formic – hydrochloric acid for 4 hr. at 115°. The top spot is due to nucleotides and unhydrolysed nucleic acid; (*b*) an artificial mixture of the nucleosides and bases known to be in the hydrolysate; (*c*)–(*h*) the components of the mixture run individually: cytidine, guanine, uridine, cytosine, uracil and adenine

we find that the relative rates of movement of these substances depend greatly on the concentration of ammonia in the vapour phase. For example, the relative positions of uridine and cytidine can be reversed by changing the ammonia vapour pressure. We also find that guanine, if in sufficiently low concentration to dissolve completely in the aqueous phase of the chromatogram, moves at a rate exceeding that of guanosine, and we imagine that it corresponds with the "epiguanine" mentioned by Hotchkiss. We think that the latter used too large an amount of guanine, and as most was undissolved it remained at the zero spot. Hydrolysis of yeast and virus nucleic acids by ammonia according to the method of Levene[6] results in the liberation of part only of the material as nucleosides, and these may be degraded still further. For example, adenosine treated in this way is found to contain four substances: adenosine, adenine and two others, probably inosine and hypoxanthine. The hydrolysis of ribonucleic acid by pyridin–water (Bredereck *et al.*[7]) is far from complete, and the hydrolysate contains at least seven different substances. In fact, we have failed so far to find a method for the quantitative hydrolysis to nucleosides. For hydrolysis of nucleic acid to the bases, the formic–hydrochloric acid mixture of Graff and Maculla[8] has been found most satisfactory for the liberation of adenine, and with prolonged hydrolysis a large part of the pyrimidine bases is liberated. The accompanying reproduction is from a photograph of a chromatogram of turnip yellow mosaic virus nucleic acid hydrolysed in this manner, showing the four bases which are also found in yeast nucleic acid.

It is possible to apply this method to the investigation of the kinetics of reactions such as the hydrolysis of nucleic acids, spots corresponding with the various products appearing and disappearing with time. Other absorbing substances, notably tryptophan, may, of course, be detected by this technique.

A fuller account of this work will appear elsewhere.

We should like to record our appreciation to Dr. Kenneth M. Smith, for his interest and encouragement, and to Dr. J. Davoll and Dr. T. Mann, for the gift of several nucleosides.

ROY MARKHAM
JOHN D. SMITH

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Dec. 23.

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Genic Differences and Rate of Growth in Yeasts

A BREWERY diploid strain of yeast kept under constant observation for the past two years showed a seasonal variation in the characteristics of its giant colonies. On the basis of normal[1] and induced reverse mutations[2], it was surmised that different mutants get established during the various seasons of the year, and hence strains having diverse genic constitutions should differ not only in their viability but also in their growth-rate under particular environmental conditions. It was shown in a previous contribution[3] that the growth-curves of the diploid and autotetraploid are widely different. Since strains having different genic constitutions were available in this Laboratory, it was considered that a study of the growth-rates of two strains assumed to be homo- and heterozygous for the *rough* allele would be interesting.

The strain *BY* 4 was isolated from an active wort culture of the control (*BY* 1) kept in a cold room for ninety days[4]. In February 1947 its giant colony had radiate folds as illustrated in Fig. 1 (1). This strain also showed a cyclical change in its characteristics, and in September 1947 the entire surface of its

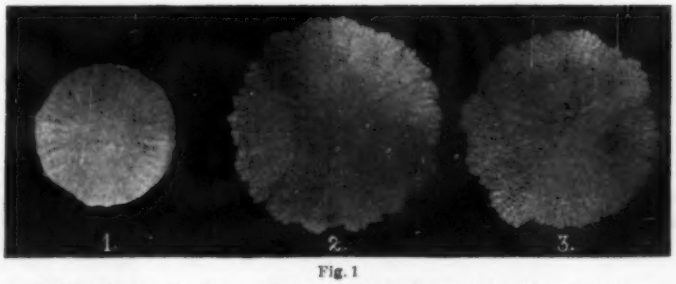

Fig. 1

BY 4. 3·6 cm. 18 days growth (Feb. 28, 1947). *BY* 4. 2·8 cm. 14 days growth (Sept. 30, 1947). *BY* 1. 3·1 cm. 16 days growth (Nov. 3, 1947)

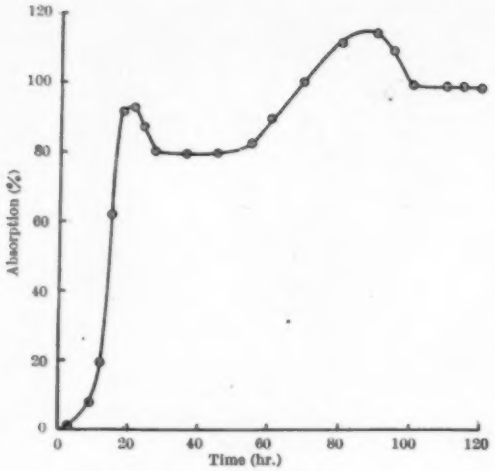

Fig. 2. Growth curve of *BY* 1

colony had a rough sculpturing (Fig. 1 (2)). During the same period the rough sculpturing was limited to the outer half of the colony in the control culture (Fig. 1 (3)). From the later orderly stages of reversion to the smooth type of colony observed in both the strains, it was assumed[4] that while the strain *BY* 4 was homozygous, the control was heterozygous for the *rough* allele.

The investigations on the growth-rates were carried out in the months of August and September 1947. The growth of yeast inoculated into 5 ml. of a standard all-vitamin synthetic medium[4] in 100-ml. conical flasks and incubated at 28° C. was measured at definite intervals using a Lumetron turbidometer. The turbidity obtained at the end of 120 hours was adjusted in each case to read 100 in the turbidometer, and the other readings were taken in terms of this standard.

While the general nature of the two growth-curves are similar (Figs. 2 and 3), the differences between the two strains are shown in the accompanying table.

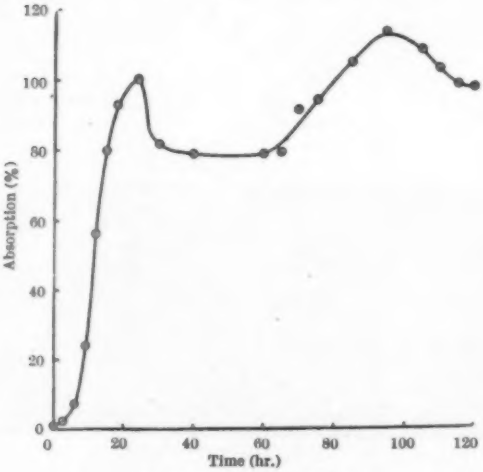

Fig. 3. Growth curve of *BY* 4

		BY 1	*BY* 4
1.	End of lag phase reached in	9 hr.	6 hr.
2.	End of logarithmic phase reached in	21 hr.	24 hr.
3.	Fall in curve	Until 33 hr.	Until 33 hr.
4.	Secondary rise commenced at	50 hr.	65 hr.
5.	Secondary maximum reached at	85 hr.	95 hr.

Dodge, Dodge and Johnson[7] observe "that there is a definite cycle of fluctuations in the physiology of the cultures". They further state: "Reappearance of very high dry weights (over 90 mgm. under our standard conditions) in approximately six-month periods suggests this as an approximation for the cycle of our stock culture" (pp. 24–25). It would be seen, however, that their explanation that "each culture behaves as liquid tissue of an individual with physiological as well as morphological differentiation of cells" is questionable in view of the explanations now offered.

A perusal of the curves would indicate that the rate of growth of *BY* 4 is slower. Hence it is likely to get gradually eliminated, if by mutation a type heterozygous for the *rough* allele originates in the active culture. Such differential viability and growth-rates of the mutants may explain the establishment of particular types (cf. Braun[8]) when grown at laboratory temperature during the different seasons of the year. It naturally follows that growth of various types of mutants ought to be different during the changing seasons of the year. Wide variations may occur between the relative growth-rates of two strains in two different seasons.

Any investigation of growth-rates of different strains would, therefore, become intelligible only if their genic constitution and variations in the same are known.

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Growth and Development of 'Mung' (*Phaseolus radiatus* Linn.)

THE effect of different times of sowing throughout the year on the growth and development of two varieties of 'mung' (*Phaseolus radiatus* Linn.)—Sona mung and I.P.28—sown in pots has been described fully in a recent paper[1]. In this note the effect of different times of sowing on the growth and development of mung sown in replicated small plots in the field will be discussed very briefly; details will be published later.

The final observations and measurements at the fruiting stage of the plants are given in the accompanying table, each figure representing the mean of twelve plants selected at random from each of the plots.

Dates of sowing	Sona mung				I.P. 28			
	Height (cm.) (*a*)	No. of nodes (*b*)	*a*/*b* (*c*)	Days for budding (*d*)*	(*a*)	(*b*)	(*c*)	(*d*)*
Aug. 15	47·6	16·6	2·9	64·6	19·2	6·6	2·9	35·0
Sept. 14	25·2	11·3	2·2	46·0	16·5	6·3	2·6	43·3
Sept. 29	13·5	5·6	2·4	35·8	11·6	5·0	2·3	39·1
Oct. 14	14·0	5·0	2·8	29·5	14·0	5·6	2·5	38·3
Oct. 29	10·4	4·5	2·3	28·6	10·3	4·6	2·2	49·6

* Days for budding = mean days required for flower-bud formation as calculated from the date of sowing up to the date when first flower-bud was just visible.

The results show that there is a correlation between the heights and the corresponding numbers of nodes in the case of both varieties, but that between the heights and the corresponding 'days for budding' is found only in the case of Sona mung. There is also a decrease in height in the case of both varieties for September 29 sowing; but the corresponding decrease in the number of nodes is only observed in the case of I.P.28. Although there is no correlation between the times of sowing and the ratio of the height to the number of nodes, it is of interest to note that the ratio always lies between 2·2 and 2·9, and that it is highest for the August 15 sowing in the case of both varieties. Again, when sowing was delayed until October, both the varieties became almost similar in height and in the number of nodes, and this was only possible due to the rate of decrease in height and in the number of nodes being much more pronounced in Sona mung than in I.P.28.

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In situ Development of Carpospores of *Bonnemaisonia asparagoides*

In their researches on *Bonnemaisonia asparagoides* (Woodw.) C. Ag., J. Feldmann and G. Feldmann[1] describe the germination of the carpospores. After showing amœboid movement, the spores become round and surrounded by a wall. The first division is equatorial and at right angles to the substratum. Other walls parallel to the first are formed, and subsequent divisions lead to the formation of a hemispherical cushion of cells from the edge of which radiating filaments ultimately develop. This account agrees with the earlier published descriptions given by Kylin[2,3] and Chemin[4], and also Golenkin[5], who recorded some variation in the position of the first wall.

During an examination of *B. asparagoides* (collected from the Tan Buoy, Millport, Cumbrae, in 1928) germinating spores were observed in three cystocarps. Some of the sporelings were free in the hollow of the cystocarp while others were still attached to the placenta (Fig. 1). The method of germination of these spores is clearly somewhat at variance with the accounts given by the authors cited above (Fig. 2). In the first place, each carpospore has germinated within the sporangium, many of the sporelings being pear-shaped and thus having the same shape as mature spores. They cannot, therefore, have shown any amœboid movement. The most notable features of the sporelings, however, are the conspicuous apical

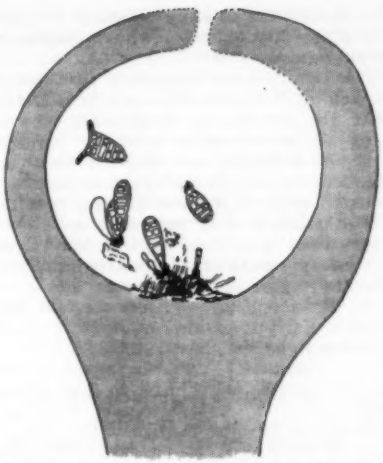

Fig. 1. Diagrammatic tracing from photograph of spores germinating in cystocarp of *Bonnemaisonia asparagoides*. (× 50)

cell (Fig. 2) and the method of germination, which resembles the bipolar type found in the Ceramiales.

Our knowledge of the life-history in this and related species, as well as of neighbouring genera, is very inadequate and incomplete, particularly with regard to the phase between the liberation of the carpospores and the re-appearance of the gametophyte. Further investigations, the need for which is indicated by these new observations on germinating carpospores, might have as their main objects: (*a*) the elimination of the apparent contradictions in existing accounts of the life-history of *B. asparagoides*, for example, whether under some conditions the gametophyte arises from a special branch of the filamentous growth[3] as well as from the tetraspores[1], and if under other conditions it may arise directly from the carpospore, as is perhaps suggested by the figures published here; (*b*) to ascertain whether the tetrasporangia, which are said[1,6] to develop on the filamentous growth originating from the carpospores, are homologous with the tetrasporangia of the Ceramiales or simply accessory reproductive spores possibly on occasions reproducing the filamentous growth; and (*c*) the effect of seasonal factors on morphological development.

In view of the rather ephemeral nature of *B. asparagoides* and its deep-water habitat, it may well be that further investigations of *Batrachospermum* under controlled conditions of culture may be the

Fig. 2. Photograph of one of the germinating spores. (× 600)

means of elucidating obscure points in the development of those Nemalionales which possess simple filamentous stages.

The Feldmanns[1] have suggested that the microscopic stage of *B. asparagoides* is a tetrasporophyte, and that the life-history might be regarded as occupying an intermediate position between the *Nemalion* and *Polysiphonia* types. While this seems unlikely, both on general grounds and because of the great dissimilarity of the two phases, it is possible that *Bonnemaisonia* may represent an elaboration of the *Nemalion* type along another line of development. The importance of this question indicates how desirable are further investigations.

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Posterior Lobe of the Pituitary Gland and the Metabolism of Lipides

THE acetone extract from posterior pituitary lobes of cattle includes a number of substances of special interest. One of these substances decreases the growth-rate of young animals, plant seedlings and transplantable mouse carcinoma[1-3]. Another substance when injected into white mice of practically cancer-free strain causes the appearance of malignant tumours in about 25 per cent of the animals treated[4].

Further investigations have shown that the extract includes a substance which, when injected into rabbit or dog, lowers the amount of cholesterol present in the blood serum[5]. The decrease affected free, as well as esterified, cholesterol.

An acetone extract of posterior pituitary lobes of cattle when successively treated with ethyl ether, ethanol, petroleum ether and methanol yields also another fraction which, after subcutaneous injection into the dog, increases the amount of cholesterol present in the blood serum of the treated animal. Two other fractions were also obtained from the acetone extract, one of which decreases the serum phospholipide content, and the second of which increases the serum lipide content in the dog.

Of the more than a hundred experiments performed we quote some typical protocols. Healthy dogs of about 8 kgm. weight were used in the experiments. Cholesterol was measured by the method of Schoenheimer and Sperry[6], phospholipides by the method of Youngburg and Youngburg[7]. The serum lipide values in mgm. per cent are given prior to, and three hours after, subcutaneous injection of the particular fractions.

I. Dog *AC*, injected with 12 mgm. of fraction *A*

Cholesterol:						
total:	before,	132·0;	after,	106·0;	decrease,	19·8 per cent
free:	,,	40·0;	,,	36·0;	,,	10·0 ,,
esters:	,,	92·0;	,,	70·0;	,,	23·9 ,,
Phospholipides:	,,	17·0;	,,	14·8;	,,	12·9 ,,

II. Dog *BX*, injected with 1·4 mgm. of fraction *B*

Cholesterol:						
total:	before,	170·0;	after,	214·0;	increase	25·8 per cent
free:	,,	44·0;	,,	64·0;	,,	45·5 ,,
esters:	,,	126·0;	,,	150·0;	,,	19·1 ,,
Phospholipides:	,,	28·5;	,,	28·5;		no change

III. Dog *M*, injected with 15 mgm. of fraction *C*

Cholesterol:						
total:	before,	150·0;	after,	160·0;	increase,	6·7 per cent
Phospholipides:	,,	23·68;	,,	19·68;	decrease	16·9 ,,

IV. Dog *S*, injected with 10 mgm. of fraction *D*

Cholesterol:						
total:	before,	186·0;	after,	182·0;	decrease,	2·2 per cent
Phospholipides:	,,	13·2;	,,	16·7;	increase,	26·6 ,,

The chromatographic separation of the cholesterol-depressing fraction *A* yielded even more interesting results. The cholesterol-depressing effect is due to three different substances, one of which lowers only the ester-cholesterol content of the serum, while the second substance lowers free cholesterol, and the third substance lowers esterified and free cholesterol both at the same rate. The action of these substances is especially manifest 24 hours after the subcutaneous injection.

We enclose typical experimental protocols giving the serum lipide values in mgm. per cent prior to, and 24 hours after, the injection of the particular fractions:

V. Dog *BH*, injected with 1·0 mgm. of fraction 33*E*

Cholesterol:						
total:	before,	108·0;	after,	72·0;	decrease,	33·3 per cent
free:	,,	28·5;	,,	28·5;	no change	
esters:	,,	79·5;	,,	43·5;	decrease,	75·4 ,,
Phospholipides:	,,	20·68;	,,	20·32;	,,	1·7 ,,

VI. Dog *BN*, injected with 12 mgm. of fraction 3*EN*2

Cholesterol:						
total:	before,	130·0;	after,	114·5;	decrease,	11·9 per cent
free:	,,	46·0;	,,	31·6;	,,	31·4 ,,
esters:	,,	84·0;	,,	82·9;	,,	1·3 ,,
Phospholipides:	,,	24·5;	,,	24·5;	no change	

VII. Dog *BQ*, injected with 10 mgm. of fraction 3*BE*

Cholesterol:						
total:	before,	167·0;	after,	100·0;	decrease,	40·0 per cent
free:	,,	52·0;	,,	30·0;	,,	42·3 ,,
esters:	,,	115·0;	,,	70·0;	,,	39·2 ,,
Phospholipides:	,,	24·1;	,,	23·5;	,,	2·5 ,,

Investigations are in progress aiming at the isolation of the active substances in a pure state.

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'Lewis' Blood-Group System

WHILE our first communication describing the Ken antigen was in the press[1], R. R. Race informed us of the discovery by Andresen of irregular agglutinins anti-L_1 and anti-L_2 [2,3], the latter giving reactions very similar to our anti-Ken serum. Andresen recognized that the L_1 character was, in fact, the 'Lewis' blood-group described by Mourant[4].

On the other hand, the anti-L_2, as our anti-Ken, gave a higher proportion of positive reactions with *O* bloods. But Andresen pointed out that the defect in positive reactions was found in the A_1 group only, while the A_2 group behaved as the *O* group. He explains the difference by an epistatic action of the property A_1 (or the gene p_1) on the development of the property L_2.

This explanation does not seem probable, in the light of the action of blood-group substances on both anti-Ken and anti-L_2 sera[4]; essentially, the addition of Witebsky's substances to anti-Ken serum and of Morgan's purified A-group substance to anti-L_2 removes the difference in the distribution of positive and negative reactions observed among O- and A-cell groups when unabsorbed serum is used.

It seems, then, more reasonable to postulate a serological explanation of the difference observed when unabsorbed serum is used: anti-Ken and anti-L_2 would contain two antibodies, one of which accounts for the agglutination of 50 per cent of bloods in all A- and O-groups, and the other capable of uniting with the A_1 receptor (as it possesses a definite affinity for the A blood-group substance) without giving any agglutination but being diverted from its specific receptor responsible for the agglutination of 'the surplus' in O- and A_2-groups.

Suitable absorption experiments should solve this problem and verify the value of our hypothesis.

We have studied a few families, and we have found that whenever Ken was absent in both parents, it could not be found in the children. On the contrary, some Ken + parents had in certain cases Ken − and Ken + children. It would appear, therefore, that Ken is dominant over its absence. This point can only be established when the exact number of agglutinins in anti-Ken serum is known.

Finally, we wish to lay stress on the possibility of immunization against the antigens of the 'Lewis' group system.

If Mourant's anti-Lewis and Andresen's anti-L_1 and L_2 sera behave like 'natural' irregular iso-agglutinins, anti-Ken was definitely of immune origin and gave rise to hæmolytic disease of the new-born.

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Colour Discrimination in the Dronefly, *Eristalis tenax*

DIFFERENTIAL reactions to various wave-lengths or wave-length bands, independent of intensity, have been claimed for several members of the group of Diptera[1-4]. None of the authors concerned, however, had based his experiments on the training method which, when applied to honey-bees, had yielded more detailed and exhaustive results than any other method[5,6]. It may therefore be of interest that a solitary insect belonging to the group of Diptera has been trained to colours successfully for the first time, in preliminary experiments carried out in this Department.

A number of droneflies, mostly *Eristalis tenax*, caught feeding on yellow flowers, were trained to find their food (sugar-water) on flower models made of coloured papers, offered in a greenhouse. The papers belonged to the Ostwald standard series which consists of twenty-four different hues; each hue, denoted by a figure (1 to 24), is available in different shades of lightness and saturation, indicated by letters following the numbers. *Eristalis* quickly learned to find their food on models cut out of the training colour Ostwald yellow 2 *na*, the letters *na* indicating the most saturated shade.

In order to find out whether the insects recognized the specific wave-length band reflected by the yellow paper, or its special degree of lightness, which need not be the same for the insect's eye as for our own, the following arrangement was offered, without any food, in the first series of test experiments: models not only in the training colour, but also in two other shades of the same yellow hue, were presented, together with models in various steps of grey, ranging from black to white, of the Ostwald grey series. We have to make the assumption that these grey papers appear neutral or near neutral also to the insect's eye, at least when illuminated by full sunlight, which was guaranteed by a large 'Perspex' window let into the south wall of the greenhouse. If the flies had selected the training colour for its particular degree of lightness, they would either have confused it with one of the grey steps, or they would have selected only one of the yellow shades.

The accompanying table, from which the wide variation in lightness value for man (reflectance) among the yellow shades is apparent, shows the results in raw figures; the proportion of coloured models to neutral ones was one in five.

Test experiment 1, 1–3. Ostwald yellow No. 2, in three shades of lightness, among various steps of Ostwald grey

	Shade	Reflectance	Visits on colour	Visits on all grey steps
(1)	Yellow 2 *ia*	0·55	29	3
(2)	Yellow 2 *na*	0·50	49	1
(3)	Yellow 2 *ne*	0·21	27	7

The selection of each of the three different shades of the same yellow hue from among all grey steps excludes the possibility that the insects were trained to one degree of lightness; they must have recognized the training colour, as well as the two other shades of yellow No. 2, by the specific wave-length region reflected. (Any influence of a smell that might be inherent in the yellow papers had been ruled out in control experiments where the whole arrangement had been covered with a 'Perspex' plate.) Accordingly, the results of the first set of tests prove the existence of colour discrimination in the dronefly.

In another set, consisting of two test experiments, models in the training colour were offered side by side with models in other colours also belonging to the saturated Ostwald *na* papers; the total number of visits was 120. The training colour No. 2 was definitely preferred to red, green, blue and violet, that is, coloured papers reflecting wave-length bands fairly different from its own; it was preferred, to a *lesser* extent, to those colours nearer to it in the Ostwald series, namely, No. 24 and No. 1 (greenish-yellow) and No. 3 and No. 4 (orange), which reflect wave-length bands similar, or adjacent, to those reflected by yellow 2, whereas their lightness values vary over a wide range.

In a third set of tests, four shades of lightness of yellow No. 2 (2 *na*, *ne*, *ia* and *ie*) were offered, together with four different shades of lightness of blue 14 (*na*, *ne*, *ia*, *ea*). The yellow shades received a total of 47 visits as compared with a total of only 3 visits on the blue shades. These results make it probable that, in the same way as the discrimination between

yellow and grey, the discrimination between yellow and various other colours, particularly between yellow and blue, is also due to differences in wave-length bands reflected, independent of differences in degree of lightness.

A spontaneous feeding response to various colours, with a high peak in yellow, has been shown to exist in the butterfly *Vanessa polychloros*[7]. Without using insects bred from pupæ, it cannot be decided whether the results mentioned thus far could not perhaps have been caused by a similar inborn response to yellow in *Eristalis*. However, this explanation does not hold good for the results obtained after an attempt to train the insects to blue, which unfortunately could not be completed owing to the end of the season. In a last series of tests carried out with *Eristalis* fed on blue 14 *na* for several days, blue shades which had been practically neglected in previous tests received at least as many visits as yellow shades (total number of visits on coloured models, 69). This proves that a certain amount of training must have been involved. Thus there is every reason to hope that *Eristalis* may prove a very suitable object for a systematic study of its colour discrimination which it is intended to carry out in this Department during next spring.

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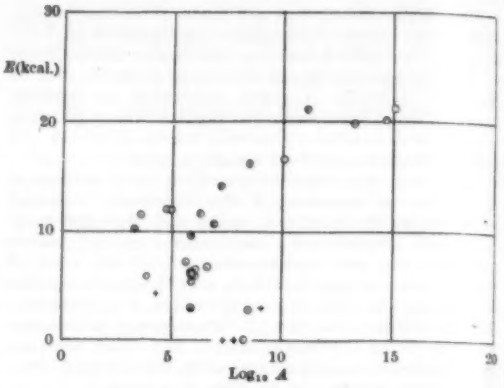
Frequency Factors in Radical Reactions

THE frequency factors and activation energies for reactions in the polymerization of styrene and vinyl acetate have been determined in these Laboratories[1]. By combining the values for chain propagation with the results of Lewis, Mayo, Walling and their collaborators[2], activation energies and frequency factors can be calculated for a number of transfer and propagation reactions of the styryl radical. The accompanying diagram is a plot of E against $\log_{10} A$ for the twenty-nine reactions. It will be seen that the frequency factors are in general low, the mean value of $\log_{10} A$ being 7·4, instead of the normal value *c.* 12. As Gregg and Mayo[2] point out, there is, however, a tendency for reactions with high activation energies to have higher frequency factors.

Attention has often been directed to the fact that frequency factors in polymerization reactions are usually low, but this has been ascribed to steric effects in the reactions of large molecules. However, any size effect should be most marked in the termination reaction in a polymerization, whereas, in the cases quoted, the latter has the highest frequency factor.

The values reported above for the autoxidation of tetralin are also plotted (crosses in the diagram). The mean value of $\log_{10} A$ for the four reactions is



7·1, in good agreement with the mean for the polymerizations. Here no size effect would be anticipated.

It seems reasonable to infer that organic radical reactions with activation energies less than about 20 kcal. in general have frequency factors of the order of 10^7, and not 10^{13} as is commonly assumed. Steacie[3] has tentatively suggested that this is also true in gas reactions.

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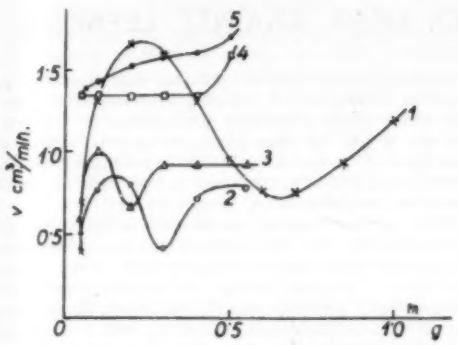
Rate of Hydrogenation in Solutions and the Mass of the Catalyst

IN order to clear up the remarkable relation between the rate of hydrogenation and the mass of the catalyst, found by Kailan and Hartel[1], as well as by Csűrős and co-workers[2], we made a systematic investigation on the hydrogenation of crotonic acid and sodium cinnamate in aqueous solutions in contact with hydrogen gas in the presence of palladium precipitated on finely dispersed barium sulphate. It was found that the product of the hydrogenation (namely, butyric acid in the experiments with crotonic acid) accelerates the reaction autocatalytically.

The initial rate of hydrogenation (v) as a function of the mass of catalyst (m) has, in pure aqueous solutions, in agreement with the authors above mentioned, a maximum and a minimum (see graph). We found that the value of v and the shape of the curve $v = f(m)$ is greatly influenced by the velocity of stirring, the ratio r of the surface to the volume of the solution, and the nature of the electrolytes present in the solution. If the velocity of stirring is moderate (magnetic stirrer moving in a circle 300 times per minute) and r being small (1–3·4 cm.^{2}/cm.^{3}), the curve $v = f(m)$ has a maximum and minimum.



Rate of hydrogenation of a 0·13 mol. sodium cinnamate solution (in v cm.³ consumed hydrogen per minute). Curve 1, sodium cinnamate alone ($r = 2·4$); curve 2, with an addition of 0·033 mol. ammonium chloride ($r = 3·4$); curve 3, the same ($r = 2·7$); curve 4, the same ($r = 1·6$); curve 5, the same ($r = 1·0$)

If, on the other hand, the solution is vigorously shaken, the rate of the hydrogenation increases proportionally with the mass of the catalyst.

The shape of the curve $v = f(m)$ is different in the presence of ammonium salts in the solution, showing, in appropriate circumstances, neither maximum nor minimum, even if the stirring is not rapid. The shape of the curve is greatly influenced by r. Varying r, v can be made independent of m; moreover, the maximum can also re-appear (see graph). The ions Na^+, H^+ and Cl^- have no such influence. It should be mentioned that the electrokinetic potential of the catalyst is essentially influenced by ammonium ions, suggesting that the alteration of the $v = f(m)$ curve is—partly at least—caused by this factor. The experimental results suggest the following explanation.

The fraction of the catalyst on the surface of the solution and near it has a greater catalytic action than the fraction in the solution. This behaviour can be correlated with various factors, one of which is the fact that the catalyst near the surface of the solution, which is in almost direct contact with the hydrogen gas, contains more adsorbed hydrogen than that in the solution, the rate of the hydrogenation being, *ceteris paribus*, undoubtedly proportional to the concentration of hydrogen per unit area of the surface of catalyst. Within the solution, the concentration of hydrogen is under stationary conditions lower than in equilibrium, having regard to the point that the reaction is consuming a certain amount of hydrogen, the support of which by diffusion and convection is rather slow.

The increase of mass of the catalyst has various effects on the rate of the reaction. On one hand, the quantity of the catalyst near the surface of the solution will be increased, accelerating the reaction, although the velocity of stirring, the pressure of hydrogen and surface area of solution are kept constant. The increased rate of hydrogenation near the surface diminishes, on the other hand, the diffusion of the hydrogen in the solution, since a greater part of the hydrogen dissolved per second from the gas will be consumed near the surface than in such experiments in which we are applying a smaller amount of catalyst, and only a smaller part of the hydrogen can be transferred into the solution. The concentration of the hydrogen is consequently diminished in the solution, and the adsorbed quantity per unit area of the catalyst diminishes also, all the more so as the whole area of the catalyst is increased.

The effect in the solution is twofold: on one hand, the increase of the whole area of the catalyst is accelerating the reaction; on the other, the decrease of the adsorbed amount of hydrogen per unit area of the catalyst is retarding it. It depends on the experimental conditions which of these two effects is to prevail. The rate of the reaction in the solution can therefore be diminished or increased by increasing the quantity of the catalyst. A more detailed development of this consideration shows that the shape of the theoretical curve $v = f(m)$ is, under adequate conditions, similar to that of the experimental curves. Further investigations on the quantitative agreement are in progress.

Fuller details of the above-mentioned experiments and considerations, carried out in collaboration with J. Szabó, will be published elsewhere.

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Sun-bathing by Birds and its Anti-rachitic Value

In the issue of *Nature* of November 27, p. 843, there is a note on the subject of sun-bathing by birds, quoting ***British Birds*** as saying that the question has been raised "whether irradiation of the skin with its consequent effect of vitamin D production would take place through sun-bathing".

In this connexion I should like to direct attention to the publications by Hou[1,2] in 1930 on this subject. Hou found by feeding tests that the skin and feathers of fowls exposed to the sun in the usual way were anti-rachitic, but that if the birds' preen glands were removed, and vitamin D excluded from their diet, they developed rickets.

From these results we can reasonably assume that one of the functions of preening is to enable the bird to secure and swallow irradiated preen gland oil, which suggests that direct irradiation of the skin is not necessary for birds to keep them free from rickets.

It seems highly probable that, in the case of mammals which have a thick enough coat of hair or fur to prevent direct access of sunlight to the skin, the sebaceous secretion which lubricates the hair contains antecedents which are converted into vitamin D by irradiation. The elaborate toilet of the fur by such animals would therefore be comparable physiologically with preening by birds. According to Hou and Tso[3], human sebum is anti-rachitic, and Hou found that if rabbits' ears were washed with ether, irradiation of the ears by a mercury vapour lamp could not cure rickets induced in the animal, but that it could if the fatty substances were not removed.

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DERIVATIVES OF *CENTELLA ASIATICA* USED AGAINST LEPROSY

Chemical Constitution of Asiaticoside

CENTELLA asiatica (Urban) (*Hydrocotyle asiatica* L.) is a plant of the family Umbelliferæ. Infusions of this plant are utilized in India and Madagascar against leprosy; it is also mentioned in the French Pharmacopœia of 1884.

Bontems[1] reported in 1942 the isolation from *Centella asiatica* of a crystalline glycoside which he called asiaticoside. Devanne and Razafimahéry[2] proposed the formula $C_{21}H_{34}O_8$ for this glycoside, and stated that hydrolysis gives one molecule of glucose and an amorphous aglucone $C_{15}H_{24}O_3$.

We have recently begun a study of the chemical constitution of asiaticoside, using crystalline material produced on a pilot-plant scale in Tananarive (Madagascar)[3]. After three recrystallizations from dilute alcohol we obtained colourless prisms, m.p. 230–233° (decomp.), $[\alpha]_D = -14°$ (in alcohol). Elementary analysis and the composition of the products of hydrolysis are in agreement with the formula $C_{54}H_{90}O_{23}$, or $C_{54}H_{88}O_{23}$ for asiaticoside (found: C, 58·18, 58·38; H, 8·32, 8·25; calculated for $C_{54}H_{90}O_{23}$: C, 58·54; H, 8·21 per cent).

Acid or alkaline hydrolysis of asiaticoside proceeds remarkably rapidly and gives an aglycone and two different sugars. These have been identified as glucose and rhamnose, by preparation of crystalline derivatives, and by partition chromatography on paper[4]. A quantitative determination of rhamnose by the method of Nicolet and Shinn[5] indicates the presence of two molecules of rhamnose for one molecule of asiaticoside (found, 28·98 per cent rhamnose; calculated, 29·63 per cent). The optical rotation of the sugar mixture formed by hydrolysis and the reducing power as determined by the method of Bertrand[6] show that asiaticoside contains two molecules of D-glucose and two molecules of L-rhamnose.

The aglycone of asiaticoside is a triterpene acid, $C_{30}H_{48}O_5$ or $C_{30}H_{50}O_5$, which we propose to call 'asiatic acid'. The hydrolysis of asiaticoside thus proceeds as shown by the following equation:

$$C_{54}H_{90}O_{23} + 4\,H_2O = C_{30}H_{50}O_5 + 2\,C_6H_{12}O_6 + 2\,C_6H_{12}O_5$$
glucose rhamnose.

Free asiatic acid is very difficult to crystallize (m.p. 240–244°, after purification through its sodium salt, m.p. 310°), but its methyl ester, obtained by methylation with diazomethane or dimethyl sulphate, crystallizes readily (needles, m.p. 225° (corr.), $[\alpha]_D = +52°$ (in alcohol) and analyses correctly for $C_{31}H_{50}O_5$ or $C_{31}H_{52}O_5$ (found: C, 73·83, 73·99; H, 10·29, 10·30; OCH_3, 6·14 per cent (Weiler, Oxford); C, 73·71; H, 10·13; OCH_3, 6·35 per cent (Manser, Zurich); $C_{31}H_{50}O_5$ requires C, 74·03; H, 10·05; OCH_3, 6·17 per cent; $C_{31}H_{52}O_5$ requires C, 73·74; H, 10·40; OCH_3, 6·14 per cent). The Zeisel determinations confirm beyond doubt the size of the molecule.

Dehydrogenation of asiatic acid with palladium-charcoal or selenium gives a hydrocarbon, the picrate and styphnate of which show no depression of melting point with the corresponding derivatives of sapotalene (1 : 2 : 7-trimethylnaphthalene), the typical dehydrogenation product of the triterpenes[7]. Typical colour reactions of the triterpenes are also positive[8].

Melting points, optical rotations and chemical and physical behaviour of different derivatives of asiatic acid show great similarity with those of other triterpene acids of the β-amyrin group; thus all evidence is in favour of the hypothesis that the carbon skeleton of asiatic acid is the same as that of β-amyrin (cf. Haworth[9], Ruzicka[7]).

Two of the oxygen atoms of asiatic acid are accounted for by the carboxyl group; the three remaining ones form hydroxyl groups. Two of these are in a 1 : 2-glycol group, as oxidation with lead tetra-acetate proceeds readily at room temperature and gives a substance precipitating with 2 : 4-dinitrophenylhydrazine. The presence of such a 1 : 2-glycol group seems to be a new feature for natural triterpene acids (cf. refs. 10, 11). The composition of crystalline acetates obtained from asiatic methyl ester is still under investigation.

The presence of a double bond in asiatic acid is indicated by the formation of a bromo-lactone, similar to that of oleanolic acid or hederagenin; tetranitromethane gives a slight colour with asiatic acid or its methyl ester.

The methyl ester of asiatic acid is very difficult to saponify, like that of similar triterpene acids containing a tertiary carboxyl group. On treating the methyl ester, m.p. 225°, with 15 per cent hydrochloric acid, it is isomerized to a new ester, m.p. 170°.

By chromatography on alumina of the crude methyl ester, m.p. 225°, we have isolated a small quantity of a dimethyl ester, $C_{32}H_{52}O_5$, m.p. 262° (found: C, 73·71; H, 10·23; OCH_3, 12·3. $C_{32}H_{52}O_5$ requires C, 74·35; H, 10·17; OCH_3, 12·28 per cent).

As asiaticoside is a neutral substance, it seems that the sugars are attached to the carboxyl group; the ease of saponification suggests that all four sugar molecules are attached in this way. Lythgoe and Trippett have made analogous observations with centelloside[10].

A comparison of our substance with those prepared in Cambridge from *Centella asiatica* from Ceylon[10,11] has shown that we have certainly different compounds in hand. We are very glad to state that we are keeping in contact with Dr. Lythgoe for the study of these triterpene acids.

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Triterpene Acids

Shortly after the announcement in Great Britain[1] that *Centella asiatica* contained a glucose derivative which was active in the treatment of leprosy, we commenced an examination of the plant, with the object of studying the chemical constitution and therapeutic properties of the active material. In this note the results of analyses carried out on dried plant tissue of Ceylonese origin are reported. We are deeply indebted to Dr. J. L. Simonsen, director of the Colonial Products Research Council, for his help in making supplies of this material available to us, and for his interest in these investigations.

No sugar derivative of the type of asiaticoside could be detected, but three triterpene acids were isolated in a pure, though amorphous, condition. It seemed that these were very likely related to the amorphous aglycone of asiaticoside, which was described[2] as giving a red colour with sulphuric acid, a reaction known to be general for triterpene derivatives[3].

The major component of our triterpene mixture, for which we propose the name 'centoic acid', was separated as the sparingly soluble potassium salt (long needles), and purified through the brucine salt, which formed plates from alcohol, $[\alpha]_D = -39°$ (pyridine). The free acid, an amorphous powder, $[\alpha]_D = +44°$ (alcohol), gave analytical data which show it to be a monobasic acid, $C_{30}H_{48}O_6$. It appears to be a normal pentacyclic triterpene acid, closely analogous, apart from its higher hydroxyl content, with oleanolic acid. It gave sapotalene on dehydrogenation with selenium. Although resistant to hydrogenation, it contains a double bond, since with tetranitromethane a yellow colour was obtained with some difficulty[4]. Among its derivatives, the following have been obtained analytically pure, although none of them could be crystallized: a methyl ester, $[\alpha]_D = +36°$ (alcohol), which was stable to hot dilute alkalis and acids; a methyl ester triacetate, $[\alpha]_D = +7°$ (alcohol), which contained one free hydroxyl group (Zerewitinoff); a periodate fission product, $C_{30}H_{44}O_8$, $[\alpha]_D = +92°$ (alcohol), requiring for its formation 1 mole of the oxidant; and a bromolactone. Centoic acid, therefore, contains a tertiary carboxyl and four hydroxyl groups, two of which are present in a cyclic 1 : 2-glycol system.

The other two triterpene acids of dried *Centella* tissue have also been shown to contain a tertiary carboxyl group, an inert double bond, and a 1 : 2-glycol system. That present in the larger quantity, for which the name 'centellic acid' is proposed, was separated by taking advantage of the high solubility of its potassium salt. The brucine salt formed pellet-like needle aggregates, $[\alpha]_D = -44°$ (pyridine), from which the free acid was regenerated as an amorphous powder, $[\alpha]_D = +36°$ (alcohol). Analytical and titration results showed it to be a monobasic acid $C_{30}H_{48}O_6$. As well as the molecular features mentioned above, it probably contains two more hydroxyl groups; but the evidence on this point is not yet clear-cut. The third acid was found present only in minor amounts. Unlike the others, it was precipitated from dilute alcohol by lead acetate. After further purification through the potassium salt (long needles), it was obtained as an amorphous powder, $C_{30}H_{48}O_6$, $[\alpha]_D = +38°$ (alcohol).

It was clearly a question of importance to find whether any of the above acids were identical with the aglycone of asiaticoside, and a short time ago we got into touch with Dr. E. Lederer, who is carrying out an investigation of asiaticoside in Paris. We have compared results on our substances, and Dr. Lederer very kindly provided us with samples of asiaticoside and of the crystalline methyl ester of its aglycone, asiatic acid; we wish to take this opportunity of thanking him for his courtesy. He and his colleagues[5] have shown asiatic acid to be a triterpene acid with properties closely analogous to those of our own acids, and with the molecular formula $C_{30}H_{48}O_5$. A direct comparison has been made with our $C_{30}H_{48}O_6$ acid, and has shown that they are not identical, but isomeric compounds.

We intend to keep in touch with Dr. Lederer, and to extend our investigations on these triterpene acids.

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Centelloside

Specimens of *Centella asiatica* grown in Madagascar have been found to contain asiaticoside[1], which is said to have value in the treatment of leprosy[2]. Lederer, Boiteau and their colleagues[3] have shown that asiaticoside is a rhamnose–glucose derivative of a triterpene acid, asiatic acid ($C_{30}H_{48}O_5$). Elsewhere[4] it has been suggested that there may be an 'oxidized form' of asiaticoside present in the fresh plant, which is more readily soluble in water.

Work carried out in this Laboratory[5] has shown that dried *Centella asiatica* tissue from Ceylon contains no asiaticoside or similar compound, but that there are present two triterpene acids $C_{30}H_{48}O_6$, closely related to asiatic acid, and traces of a third isomeric with it. It seemed likely that these sugar-free triterpenes might originate as a result of enzyme action on one or more sugar derivative present in the fresh plant, and evidence is now presented which supports that view.

When alcoholic extracts of fresh Ceylonese plant tissue were analysed, free triterpene acids were found only in amounts too small to permit identification. In one fraction of the extracts, however, combined triterpene was present in considerable quantity. This fraction was purified extensively, until only small traces of free sugar were present (as shown by paper chromatography), but no crystalline material could be obtained from it. We think, nevertheless, that it consists substantially of a single substance, which contains a triterpene acid in combination with a sugar system. Its chemical properties resemble closely those of asiaticoside, and accordingly we suggest for it the name 'centelloside'.

Centelloside forms a pale yellow neutral gum, extremely soluble in water, much less soluble in anhydrous alcohol. It reduces Fehling's solution on warming. Dilute acids liberate from it reducing sugars and a triterpene acid, which was identified as centellic acid[5] by conversion to the crystalline brucine salt. The sugar solution left after removal of centellic acid from the hydrolysate was investigated

using a variety of techniques. Glucose was identified by paper chromatography[6], and as the phenylosatriazole derivative[7]. Qualitative and quantitative[8] application of the Seliwanoff reaction showed the presence of a ketose; the optical rotation of the solution identified this as fructose. Rhamnose, which is a component of asiaticoside, was absent. Estimations of total reducing power, and of formaldehyde produced on oxidation with periodate[9], combined with the previous data, gave for centelloside the composition: centellic acid : glucose : fructose = 1 : 10 : 2 (mol.). Since strict proof of the homogeneity of the preparation is lacking, these figures must be regarded as provisional, but they show that centelloside carries a much larger sugar system than asiaticoside, and to this, and to the fructose content, the hydrophilic nature is probably due.

A property of centelloside which calls for special comment is the behaviour with warm dilute alkali, which rapidly sets free the salt of the aglycone, while destruction of the sugar colours the solution yellow. This high lability to alkali makes it unlikely that any part of the sugar is bound glycosidically to triterpene hydroxyl groups, and is sufficient to account for the action on Fehling's solution without assuming a free reducing centre in the sugar system. The aglycone, centellic acid, has no reducing properties.

The neutral nature of centelloside suggests at once that the linkage between sugar and triterpene is of the ester type. It must be borne in mind, however, that the carboxyl of centellic acid is sterically hindered, like that of oleanolic acid, and the behaviour of two synthetic glucose derivatives of the latter has been found to accord with theoretical expectation, and to diverge from that of centelloside. 1-β-Oleanolyl glucose, m.p. 216–218° (decomp.), $[\alpha]_D = +46{\cdot}5°$ (alcohol), is hydrolysed by acids, but stable to alkalis. 6-(Acetyloleanolyl) glucose, m.p. 235° (decomp.), $[\alpha]_D = +81°$ (alcohol), although destroyed by alkalis, is stable to acids. The alkalilability of centelloside remains unexplained, and clarification is being sought, *inter alia*, by the preparation of centellic esters of different sugars.

It is of interest that the Ceylonese variety of *Centella asiatica* apparently produces no asiaticoside but this closely related compound. Whether this reflects a morphological difference, or merely one of habitat or season, we are not competent to decide.

We are indebted to Dr. J. L. Simonsen, director of the Colonial Products Research Council, and to Dr. R. Child, director of the Coconut Research Scheme, Lunuwila, Ceylon, for making the fresh plant material available to us; the plants were identified botanically at the Department of Agriculture, Peredeniya, Ceylon.

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ELEMENTARY BODIES OF VARICELLA AND HERPES ZOSTER

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DESPITE the prevalence of varicella and herpes zoster, little information is available concerning the infective agents themselves, since susceptible experimental animals providing adequate quantities of the viruses have not been found. Optical microscopical observations on the morphology and size of stained varicella virus have been made by Aragão[1], Paschen[2], Amies[3] and, more recently, by van Rooyen and Illingworth[4]. The last-named workers describe the infective agent as having a diameter of 1,250-1,750 A., and as being appreciably smaller than the elementary bodies of vaccinia and variola. Particles of the size stated are at the limit of resolution of the optical microscope, so little information is available concerning the elementary body itself.

Ruska[5] has reported an electron microscopic study of these viruses in a journal not available to us. Ruska's work was published before the 'shadow-casting' technique of Williams and Wyckoff[6] was devised, but we have used this method in a study of these viruses. The electron microscope used was an R.C.A. Model *EMU*.

The material used was fluid withdrawn from early vesicles in cases of chickenpox and shingles and variously diluted with normal saline to one-fifth to one-twentieth of the original concentration. Approximately 0·01 c.c. of the diluted fluid was allowed to evaporate to dryness on a collodion film stretched across a wire-mesh specimen screen, washed with distilled water to remove soluble salts and then 'shadow-cast' with platinum as recommended by Williams and Backus[7]. A thickness of *c.* 7 A. of platinum was deposited at such an angle that the shadow-lengths were 3·9 times the heights of the corresponding particles.

In fluid direct from the vesicles of four of the five cases of chickenpox examined, a number of bodies of regular size and shape were seen. The identity of these bodies with the causative agent of varicella was established by making two sets of preparations. The first (*a*) consisted of equal volumes of vesicle fluid diluted one-in-five with normal saline and of serum similarly diluted, taken from a patient 24 hours after the onset of an attack of chickenpox. Set (*b*) was similarly prepared except that the serum used was taken from the same patient on the eighth day of the disease. Both mixtures were allowed to stand for one hour at 22° C. before a portion was transferred to specimen screens and dried. Preparation (*a*) showed a uniform dispersion of particles which occurred singly; by contrast, preparation (*b*) showed considerable aggregation of the particles (Fig. 1).

Only two cases of herpes zoster were available for examination, and the vesicle fluid of one of these was found to contain particles indistinguishable in size

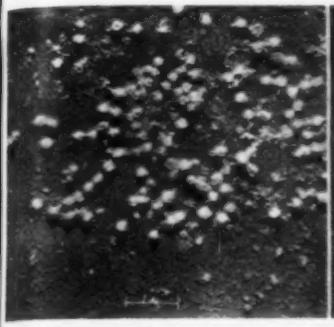

Fig. 1

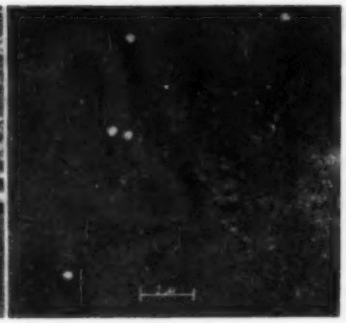

Fig. 2

Fig. 1. Varicella virus agglutinated with convalescent serum. Shadow-cast with platinum. Shadow ratio, 3·9

Fig. 2. Varicella virus fixed with 0·5 per cent osmic acid. Shadow-cast with platinum. Shadow ratio, 3·9

and shape from those observed in varicella. In view of the well-known fact that an attack of either herpes zoster or of varicella affords immunity against the other, attempts to observe agglutination of herpes zoster virus by convalescent serum from a case of varicella were made. Once again the convalescent serum caused much more marked aggregation of the virus than did the onset serum.

The profile of the virus particles shown in the micrographs is roughly circular; but measurements of shadow-lengths (see table) indicate that they are not truly spherical but oblate. In fact, the appearance of the particles is that of caps of ellipsoids, suggesting that the particles have collapsed to various extents on drying at room temperature. Evidence in support of this view was obtained by fixing the particles by the addition of osmic acid or formalin to the virus suspensions in saline. When so fixed, the virus particles approach more closely to the spherical form when dried (Fig. 2). As the micrographs yielded insufficient information for the calculation of the volumes of the unfixed virus particles as caps of ellipsoids, they were treated as caps of spheres and their volumes were found to agree with those of the fixed particles treated as ellipsoids (see table).

	No. of particles measured	Mean diameter (A.)	Mean height (A.)	Mean volume (10^6 A.^{3})
Varicella virus	77	2420±30	730±15	1880±60
Varicella virus and onset serum	30	2420±30	750±30	1950±90
Varicella virus and convalescent serum	45	2450±40	800±20	2150±80
Varicella virus and 5 per cent formalin	14	1860±70	1030±40	1870±160
Varicella virus and 0·5 per cent osmic acid	14	1750±35	1180±50	1890±110
Herpes zoster virus	19	2530±80	790±30	2240±160

Hodge[8], of this Laboratory, has observed a similar effect on fixing influenza virus particles with phosphotungstic acid. Similar observations have been made by Dawson and McFarlane[9] on the brick-shaped particles of vaccinia virus. They found particles dried at room temperature had the same lateral dimensions as freeze-dried particles but were only half the height. Particles fixed with osmic acid had the same volume as the particles dried at room temperature; but all dimensions were 20 per cent less than those of freeze-dried particles. It appears that fixed particles retain their true shape to a greater extent than those dried at room temperature, but freeze-drying is required if the true shape and size are sought.

Statistical treatment shows that the untreated varicella virus particles are significantly smaller than those treated with convalescent serum and are also smaller than herpes zoster virus particles. However, our preparations contained too much extraneous protein material to allow any real significance to be attached to these differences. The mean particle dimensions and their standard errors given in the table depend on magnification calibration obtained by means of interferometrically measured glass fibres as described by Farrant and Hodge[10].

Virus particles treated with phosphotungstic acid and osmic acid show areas of differing densities suggesting internal structure, but no evidence of this could be seen in the unstained particles.

The identity of these bodies with the causative agent of varicella is not conclusively established, as it has not been possible to attempt the reproduction of the disease by purified suspensions of them. It is not, therefore, possible to satisfy Koch's postulates; but the occurrence of the particles in the vesicle fluid of four out of five patients suffering from chickenpox, and the development of serum agglutinins for the bodies observed, during the course of the disease, give a high degree of probability that they are the cause of chickenpox.

Since this work was completed, we have received a paper by Rake and Nagler[11] showing electron micrographs of varicella virus. The particle dimensions in the horizontal plane, given by them, differ from those obtained by us; but it is evident from our own observations that size depends, to a great extent, upon the mode of preparation of the specimen for examination.

We desire to thank Dr. W. Stephenson and Dr. A. Ferris, of the Infectious Diseases Hospital, Fairfield, Melbourne, who kindly supplied the specimens for investigation. We also thank Dr. A. L. G. Rees, of the Division of Industrial Chemistry, for his interest in this work.

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[7] Williams, R. C., and Backus, R. C., *J. App. Phys.*, **19**, 119 (1948).
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[10] Farrant, J. L., and Hodge, A. J., *J. App. Phys.*, **19**, Sept. (1948).
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MECHANICAL WEAR

SUMMER CONFERENCE AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

A SPECIAL summer conference on mechanical wear was held at the Massachusetts Institute of Technology, Cambridge, Mass., on June 14–16, under the joint sponsorship of the American Society of Mechanical Engineers, the General Motors Corporation and the Chrysler Corporation, together with the Institute itself. The object of the conference was to take stock of the present knowledge and theories on this very important subject so that the most profitable directions of future research might be more clearly indicated. The absence of any general meeting on the subject in either the United States or Europe during recent years made this especially desirable.

The papers presented and accompanying discussion covered laboratory and service experience on wear in internal-combustion engines, steam turbines, brake materials, journal bearings, gears, electric brushes (in the absence of electric currents), surface plates and cutting tools. In addition, results of laboratory tests on laboratory machines simulating some of these service operations and also on specially designed wear-test machines were reported. Specifically excluded from consideration at the conference were the subjects of cavitation erosion by liquids and the wear of current-carrying electric contacts.

It was the general consensus that the wear phenomenon is exceedingly complex and depends on numerous factors. Some of these factors were discussed in considerable detail by one or more of the speakers. They included hardness, fatigue strength, gas adsorption, chemical reaction and viscosity. These discussions were too long to report here in detail, but the following notes indicate matters which were especially interesting to those present.

F. P. Bowden and D. Tabor (University of Cambridge) summarized the various ways in which rubbing surfaces can operate, depending on the quantity and type of lubricant present (in other words, full-fluid, boundary or dry), and they cited various evidence for presence or absence of metal-to-metal contact in each of the three regions. The evidence showed, on one hand, intermittent contact even under conditions of sliding hydrodynamic lubrication, but on the other hand the transmission through thick oil-films of compressive stresses exceeding the yield point of the metal without direct solid contact. In a separate connexion they showed that fatty acids, which are supposed to attack metal surfaces chemically to form metal soaps which are very effective boundary lubricants, will not attack these same metal surfaces if the latter have not previously been exposed to air and moisture. R. Savage (General Electric Research Laboratory) described his recent findings on the mechanism of the lubrication and wear of graphite. He found that the presence of oxygen or water vapour was necessary for graphite to lubricate in its familiar manner. In the absence of these gases it wears extremely badly, producing a fine dust having strong surface-active properties.

E. S. Starkman and A. G. Cattaneo (Shell Development Company) showed that the corrosive wear of piston rings increased with the amount of sulphur in the fuel, owing to formation of sulphur trioxide; it increased with the amount of tetra-ethyl lead in the fuel owing to the simultaneous presence of the halogen scavenger, and it increased sharply below the dew-point of the water vapour in the combustion gas mixture owing to the formation of carbonic acid. R. Holm (Stackpole Carbon Company) proposed a relation, for the purpose of correlating wear measurements, which involves the hardness of the rubbing surfaces. He also discussed the relation of this contact hardness, as measured by an indenter, to the yield point of the metal. In addition, he showed that the measured contact-hardness depended on the size of the indenter.

H. Blok (Royal Dutch Shell, Delft) showed that the failure of gear teeth under exaggerated impact loading depended much more on the viscosity of the lubricant than on its oiliness or extreme-pressure characteristics. This was attributed to the ability of viscous liquids to withstand suddenly applied compressive loads. J. O. Almen (General Motors Research Laboratories) discussed the wear of gear teeth and especially that type known as scoring or welding wear. He showed a correlation between failure due to this type of wear and the product of the factors of compressive stress, sliding velocity, and the length of time the teeth are in contact. E. Buckingham (Massachusetts Institute of Technology) and G. J. Talbourdet (United Shoe Machinery Corporation) reported data on the failure of gear materials from another type of wear, namely, pitting fatigue.

J. H. Dedrick (University of Cincinnati) and John Wulff (Massachusetts Institute of Technology) described friction and wear measurements on certain ternary-bronze powder-metallurgy brake-materials containing lead, graphite and silica. They found that only a small region on the corresponding ternary diagram gave alloys having suitable characteristics as regards wear-rate and quiet operation. This area is limited to compositions containing both lead and graphite, but silica is not necessary. R. G. Larsen (Shell Development Company) tabulated and discussed all the possible adsorption and chemical reactions that could take place between the rubbing metal surface and its gas or lubricant environment. These were found to be quite numerous and sometimes complex. C. M. Allen (Battelle Memorial Institute) reported qualitative information on the minimum oil-film thickness in a fluid-lubricated journal-bearing just prior to failure. He measured the electric break-down potential of the oil film and showed that this often gave warning of impending failure.

The complete proceedings of the conference will be published shortly by the American Society for Metals, Cleveland, Ohio. J. T. BURWELL, JUN.

ORIGIN OF THE SOLAR SYSTEM

PROF. HAROLD JEFFREYS has published a paper in which he examines a number of theories proposed to explain the origin of the solar system[1]. In the early part of the paper he points out that the resonance theory of the origin of the moon can no longer be maintained; and, in fact, it was shown many years ago to be quite untenable for various reasons, though it is still referred to in popular works as a possible explanation of the existence of our satellite. Dealing with the origin of the planetary system, he refers to his earlier view of a collision between the visiting star and the sun, which appeared to make some successful quantitative predictions,

but which Russell showed to be dynamically unsound. Lyttleton's theory that at the time of the encounter with the visiting star the sun was a double star, and that the encounter was with the companion, seemed to offer a way out of the difficulty. On this theory there was the possibility that the visiting star and the companion would escape from the neighbourhood of the sun, and yet leave a considerable fraction of the ejected matter revolving around the sun. Nevertheless, as Jeffreys shows, in all catastrophic theories there is a fundamental difficulty. In Jeans's tidal theory it was assumed that the elongated filament would be gravitationally unstable and would break up into a number of pieces—a view which is difficult to maintain if the matter ejected from the sun (or its companion) had an initial high temperature. Jeffreys investigated a number of cases nearly twenty years ago and showed the difficulties in the view that the gravitation of the mass could maintain equilibrium, though there was the possibility that adiabatic cooling during expansion would lead to the formation of liquid drops at an early stage, and thus the pressure might be relieved before the velocities became uncontrollable. More recently, Spitzer dealt with the same problem and concluded that during the expansion of cylindrical and ribbon-like filaments these would disappear completely.

Another difficulty arises in connexion with the compositions of the planets; it is interesting to note that the greater densities of the inner planets find a natural explanation if they were originally gaseous, because the greater masses of the outer zones would retain lighter materials, which would be lost by the smaller ones. If bodies of different masses were set free suddenly in a vacuum, we should expect that there would be these differences in composition; if gradual evolution took place, the materials would be mixed and the compositions nearly uniform. Hence the present condition of the inner and outer planets favours a catastrophic theory which, as has just been pointed out, is itself open to very serious objections. At this stage Jeffreys discusses some recent results on possible modes of disruption of rotating bodies, and deals with the question of a disrupted planet giving rise to two or more independent planets, thus accounting for the differences of composition among the inner planets. Originally there might have been one or two bodies which acquired too rapid a rotation for stability as they condensed, but before the development of instability the central cores would have had time to form. Lyttleton suggested that all the planets could be brought into this scheme, and secondary disturbances, like a splash, might be associated with the separation. Some pieces might continue with each of the main bodies, giving rise to satellites, while others might become independent of both bodies, forming the terrestrial planets and the moon. In 1941 Lyttleton showed that a planetary system might be formed by fission without any external disturbance. Starting with a triple star with two very close companions, he showed that if these coalesced the angular momentum would be sufficient to produce fission and make them separate indefinitely. The two parts might both escape from the third body (the sun) while leaving part of the splash to be captured by it. The accretion of interstellar matter would cause the coalescence of the two companions, and, as Jeffreys admits, there is no obvious quantitative objection to this theory except that just referred to, namely, the high initial temperatures of the planets.

Although the existence of small bodies presents a difficulty in all theories, owing to their feeble gravitational pull on their material, and Lyttleton's fission theory of the planets offers some hope of explanation as the fission was supposed to have taken place after liquefaction, there is another possible explanation. A liquid or solid, however small, will grow if immersed in a gas, provided that the density of the gas exceeds the saturation vapour density at the actual temperature. A. L. Parson has dealt with this problem[2], and it seems that even with the present small density of interstellar matter, iron, calcium oxide, magnesium oxide and silicon dioxide are capable of condensing; but water, methane and ammonia would be unlikely to condense near Jupiter and Saturn at the probable densities—about 10^{-18} gm. per c.c. Jeffreys admits that Parson's results answer one of his chief objections to the planetesimal theory that the small bodies would collide and volatilize one another before they could produce any notable effect on the planets. If they did, the vapour would condense again and form new dust, the accretion of the planets proceeding. Hoyle has examined the question of accretion by the planets[3] and finds that it would take place at an increasing rate as the planet became larger; and if a condensation reached the mass of the earth, it would grow rapidly to attain a mass of the order of that of one of the major planets.

Other theories on the formation of the planets and satellites are considered; but Jeffreys is not satisfied with any of the existing theories. Thus he says: "But many notable advances have been made in the last twenty years, and the problem is to decide which of them are relevant to the origin of the solar system".

[1] *Mon. Not. Roy. Astro. Soc.*, **108**, 1 (1948).
[2] *Mon. Not. Roy. Astro. Soc.*, **105**, 244 (1945).
[3] *Mon. Not. Roy. Astro. Soc.*, **106**, 406 (1946).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 14

INSTITUTION OF THE RUBBER INDUSTRY, MIDLAND SECTION (joint meeting with the BIRMINGHAM SECTION of the ROYAL INSTITUTE OF CHEMISTRY, at the James Watt Memorial Institute, Great Charles Street, Birmingham), at 7 p.m.—Dr. H. W. Melville, F.R.S.: "The Degradation of High Polymer Substances".

INSTITUTION OF THE RUBBER INDUSTRY, PRESTON SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY, the SOCIETY OF CHEMICAL INDUSTRY, and the BRITISH ASSOCIATION OF CHEMISTS at the Victoria and Station Hotel, Preston), at 7 p.m.—Dr. W. J. S. Naunton: "Natural and Synthetic Polymers" (with special reference to Rubber and Synthetic Fibres).

Tuesday, February 15

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, BIOLOGICAL METHODS GROUP (joint meeting with the AGRICULTURAL GROUP of the SOCIETY OF CHEMICAL INDUSTRY, in the Chemistry Department, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Discussion on "The Evaluation of Selective Weedkillers" (to be introduced by Dr. M. A. H. Tincker).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Edward Salisbury, F.R.S.: "Types of Distribution in the British Flora". (Further Lectures on February 22, March 1 and March 8.)

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.15 p.m.—Dr. A. Schweitzer: "Reflexogenic Areas of the Vascular System".* (Further Lectures on February 22, March 1, March 8 and March 15.)

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. T. R. C. Fox: "Technical Education".

INSTITUTION OF THE RUBBER INDUSTRY (at Caxton Hall, Caxton Street, London, S.W.1), at 7 p.m.—Dr. C. Bondy: "The Colloidal Aspect of Rubber Latices": Dr. W. H. Bodger: "The Applications of Various Types of Rubber Latex".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The International Organisation of Science". (Speakers: Prof. M. J. Sirks, Prof. F. J. M. Stratton, F.R.S., Dr. Joseph Needham, F.R.S., and others.)

Wednesday, February 16

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Discussion on "Large-scale Vertical Motion in the Atmosphere".

ROYAL MICROSCOPICAL SOCIETY (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. R. Barer: "Reflecting Microscopes—Past, Present and Future".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND S.E. COUNTIES SECTION (at 30 Russell Square, London, W.C.1), at 6.30 p.m.—Dr. G. M. Bennett, F.R.S.: "The Work of the Government Laboratory".

OIL AND COLOUR CHEMISTS' ASSOCIATION, LONDON SECTION (at Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Dr. D. V. N. Hardy: "Silicones".

ROYAL STATISTICAL SOCIETY, NORTH-EASTERN GROUP of the INDUSTRIAL APPLICATIONS SECTION (at the Chemical Industries Club, 18 Lovain Place, Newcastle-upon-Tyne), at 6.30 p.m.—Mr. E. D. van Rest: "Probability and the Experimenter". (To be repeated on Thursday, February 17, at the William Newton School, Norton, Stockton-on-Tees, at 7.15 p.m.)

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS GROUP (joint meeting with the LONDON SECTION of the PLASTICS INSTITUTE, at the Waldorf Hotel, Aldwych, London, W.C.2), at 6.30 p.m.—Dr. H. M. Stanley: "Petroleum Hydrocarbons as Raw Materials for the Plastics Industry".

Thursday, February 17

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. G. Burniston Brown: "The New Philosophy of Science".*

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. Jack Spalding: "Ground Control—Theory and Practice".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. P. Erdös: "An Elementary Proof of the Prime-Number Theorem".

BRITISH GLACIOLOGICAL SOCIETY (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5.15 p.m.—Discussion on "The Origin of Ice Pyramids and Dirt Cones on Glaciers".

CHEMICAL SOCIETY, NORTH WALES SECTION (joint meeting with the UNIVERSITY COLLEGE OF NORTH WALES and UNIVERSITY OF LIVERPOOL CHEMICAL SOCIETIES, in the Department of Chemistry, University College of North Wales, Bangor), at 5.30 p.m.—Dr. W. H. J. Vernon: "Corrosion, the Study of Surface Reactions on Metals".

CHEMICAL SOCIETY, SHEFFIELD SECTION (joint meeting with the SHEFFIELD UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Department Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. W. F. K. Wynne-Jones: "Hydrogen Peroxide as an Ionizing Solvent".

UNIVERSITY OF LONDON (in the Department of Civil, Mechanical and Chemical Engineering, King's College, Strand, London, W.C.2), at 5.30 p.m.—Mr. D. H. Lee: "Foundations with reference to Soil Mechanics and Mining Subsidence".*

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 7 p.m.—Discussion on "Electronic Equipment for the Engineer".

TEXTILE INSTITUTE (at 16 St. Mary's Parsonage, Manchester), at 7.15 p.m.—Mr. A. W. Bayes: "The Function of Testing in Production".

TEXTILE INSTITUTE, BURNLEY BRANCH (at the Mechanics' Institute, Manchester Road, Burnley), at 7.15 p.m.—Mr. A. M. Robertson: "Fibreglass and its Uses".

CHEMICAL SOCIETY (in the Main Chemistry Lecture Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 7.30 p.m.—Prof. Dr. V. Prelog (Zurich): "Recent Developments in the Chemistry of Macrocyclic Compounds".

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. A. F. Mahaffy: "The Epidemiology of Yellow Fever in Central Africa".

Friday, February 18

BIOCHEMICAL SOCIETY (at St. Thomas's Hospital Medical School, London, S.E.1), at 2 p.m.—Scientific Papers.

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 2 p.m.—Symposium on "Operational Aspects of Marine Radar".

ASSOCIATION OF APPLIED BIOLOGISTS (in the large Chemistry Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 2.15 p.m.—Annual General Meeting: Mr. W. C. Moore: "The Significance of Plant Diseases in Great Britain" (Presidential Address).

EUGENICS SOCIETY (at Manson House, 26 Portland Place, London, W.1), at 5 p.m.—Rt. Rev. the Lord Bishop of Birmingham, F.R.S.: "The Mixing of Races and Social Decay" (Galton Lecture).*

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Discussion on "Rotary, Oscillating and Reciprocating Seals" (to be opened by Mr. T. E. Beacham and Mr. F. H. Towler).

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Dr. F. P. Bowden, F.R.S.: "Friction".

SOCIETY OF INSTRUMENT TECHNOLOGY, MIDLAND SECTION (at the Arden Hotel, New Street, Birmingham), at 7 p.m.—Mr. N. F. Astbury: "Some Instruments for Iron Testing".

SOCIETY OF GLASS TECHNOLOGY, NORTH-WEST SECTION (at the Gas Showrooms, Radiant House, St. Helens), at 7.15 p.m.—Mr. W. J. R. Merren: "The Application of Electronics in Glass Manufacture and Glass Research".

ROYAL SOCIETY OF MEDICINE, RADIOLOGY SECTION (joint meeting with the BRITISH INSTITUTE OF RADIOLOGY and the FACULTY OF RADIOLOGISTS, at 1 Wimpole Street, London, W.1), at 8.15 p.m.—Discussion on "The Physical, Cytological and Medical Aspects of Protection from Ionizing Radiations with Special Reference to the Use of High Voltage X-Rays and Radio-Isotopes" (to be opened by Sir Ernest Rock Carling, Dr. Katharine Williams and Mr. Marley).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. Homer A. Thompson: "The Agora of Ancient Athens: a Study in Archæological Restoration".

Saturday, February 19

PHYSICAL SOCIETY (in the Department of Natural Philosophy, The University, Edinburgh), at 10 a.m.—Scientific Papers.

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND S.E. COUNTIES SECTION (at the University, Reading), at 3 p.m.—Prof. F. E. Simon, F.R.S.: "Experiments on Solid Helium".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN BIOLOGY—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (February 21).

PRINCIPAL SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER for research on problems of heat exchange, SENIOR SCIENTIFIC OFFICERS (2) for research on (*a*) fluid mechanics and (*b*) kinematics and mechanisms, a SENIOR EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER to prepare detailed designs of plant, equipment and apparatus for a new hydraulic machinery research laboratory, and a SENIOR EXPERIMENTAL OFFICER (Engineer) for general duties connected with the development of new laboratories including an engineering workshop; in the Mechanical Engineering Research Organisation of the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2388 (February 22).

PRINCIPAL SCIENTIFIC OFFICERS and EXPERIMENTAL OFFICERS in the Medical Statistical Department of the Directorate of Hygiene in the War Office—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2390 (February 22).

LIBRARIAN in the Department of the Scientific Adviser to the Army Council at the War Office—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2396 (February 24).

LECTURER IN MATHEMATICS at the Military College of Science, Shrivenham, near Swindon—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.335/48A (February 26).

VETERINARY RESEARCH POSTS (Principal Scientific Officer or Senior Scientific Officer grades, unestablished) at a Ministry of Supply research and development establishment in Wilts—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.8/49A (February 26).

CHAIR OF GEOLOGY—The Secretary, The University, Birmingham 3 (February 28).

PRINCIPAL SCIENTIFIC OFFICERS, SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS (unestablished, with good honours degree or equivalent in mathematics, physics, mechanical or aeronautical engineering), at the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.451/48A (February 28).

SENIOR or JUNIOR PHYSICAL CHEMISTS for the British West Indies Sugar Research Scheme—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (February 28).

LEVERHULME RESEARCH FELLOWSHIPS—The Secretary, Leverhulme Research Fellowships, 7 Bedford Row, London, W.C.1 (March 1).

SCIENTIFIC OFFICER (zoologist) to carry out research on fish and fisheries under the personal supervision of the Director—The Secretary, Scottish Marine Biological Association, 185 St. Vincent Street, Glasgow, C.2 (March 1).

DIRECTOR OF THE ASSOCIATION, a DEPUTY DIRECTOR AND HEAD OF THE DEPARTMENT OF APPLIED PHYSICS, and a PSYCHOLOGIST, at the Ahmedabad Textile Industries' Association, Ahmedabad—The Office of the High Commissioner for India, Scientific Liaison Office, India House, Aldwych, London, W.C.2 (March 1).

LECTURER IN EDUCATIONAL PSYCHOLOGY—The Registrar, University College, Hull (March 1).

SENIOR or JUNIOR PHYSICAL CHEMISTS at the Imperial College of Tropical Agriculture, Trinidad—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (March 5).

I.C.I. RESEARCH FELLOWSHIPS IN BIOCHEMISTRY, CHEMISTRY, ENGINEERING, PHARMACOLOGY or PHYSICS—The Secretary of University Court, The University, Glasgow (March 15).

CHAIR OF PHILOSOPHY, and LECTURESHIPS IN MATHEMATICS, BOTANY and CHEMISTRY, at the University College of the Gold Coast—The Secretary, Inter-University Council, 8 Park Street, London, W.1 (March 19).

DIRECTOR—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (March 31).

BIOCHEMIST with research experience for research and development work of physico-chemical nature in relation to human plasma products, and a JUNIOR grade for work of an immuno-chemical nature, at the Institute's Elstree laboratories—The Secretary, Lister Institute, Chelsea Bridge Road, London, S.W.1.

PHYSICAL CHEMIST—The Secretary, Research Association of British Rubber Manufacturers, 105–7 Lansdowne Road, Croydon, Surrey.

ASSISTANT CHEMIST at the Courtauld Institute—The Secretary, Middlesex Hospital Medical School, London, W.1.